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The Great Apes

A STUDY OF ANTHROPOID LIFE

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The Great Apes

A STUDY OF ANTHROPOID LIFE

BY

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AND

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THE GREATEST THING A HUMAN SOUL EVER DOES IN THIS WORLD IS TO SEE SOMETHING, AND TELL WHAT IT SAW IN A PLAIN WAY. HUNDREDS OF PEOPLE CAN TALK FOR ONE WHO CAN THINK, BUT THOUSANDS CAN THINK FOR ONE WHO CAN SEE. TO SEE CLEARLY IS POETRY, PROPHECY, AND RELIGION,—ALL IN ONE.

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ROBERTA WATTERSON YERKES AND DAVID NORTON YERKES

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WITH FAITH IN THEIR ABILITY TO CARRY FORWARD

THE WORK WHICH FOR A SEASON WAS COMMITTED TO US

PREFACE

PREPARATORY to systematic and long-continued utilization of anthropoid apes as objects of psychobiological research, we have catalogued, digested, abstracted, and, as necessary, translated the literature of anthropoid life. Our files are useful aids to the investigator who may be at hand to consult them. This volume is our attempt to share our laboriously achieved informational resources with all who may wish to acquaint themselves generally with the subject, to study aspects of it intensively, or to consult the relevant literature. Only incidentally does the volume support theses or present hypotheses; it is offered, in the disinterested spirit of science, to promote knowledge and enlightenment through the encouragement of honest, painstaking, unprejudiced observation.

Included among anthropoid apes, in this volume, are the *Hylobatidae* (gibbons and siamangs). If we were beginning our task anew, we should consider only the three types of great ape: orang-outan, chimpanzee, and gorilla, for whereas they are strikingly alike structurally and psychobiologically, the *Hylobatidae* differ conspicuously from them. Moreover, all things considered, the great apes stand nearer to man, and the gibbons and siamangs nearer to monkey. We should not actively quarrel with the taxonomist concerning the inclusion of the *Hylobatidae* among anthropoid apes, but without hesitation we should omit them, because they differ so markedly from orang-outan, chimpanzee, and gorilla.

The plan of our book is evident from the Table of Contents and we would here merely comment on certain of its features. An introductory historical part was clearly indicated as desirable; so also, in our opinion, was the separate consideration of each anthropoid type. By devoting parts of the volume to gibbon, orang-outan, chimpanzee, and gorilla, respectively, we hope that we have succeeded in avoiding confusion of types and in achieving definiteness and legitimate sharpness of descriptive contrast.

In each part materials have been arranged topically, but the categories used and their order vary somewhat for the several types of anthropoid ape. Since functional expressions of the organism are our primary concern, morphological descriptions and references, except as necessary for orientation of the student of psychobiology, have been omitted.

Authorities have been cited freely and wherever feasible quoted literally or in free condensed translation. This has considerably increased the length of our exposition, but it should also render it more valuable historically and more accurate. To avoid a polyglot text we have quoted only in English.

Originally projected as an objective historical account of knowledge of anthropoid life, the manuscript tended to become increasingly critical and original as we proceeded with its preparation. The first two parts—History and Gibbon—are almost wholly historical digests. In them the authors appear as expositors, not as investigators. In the Orang-outan, we quite unintentionally departed from our chosen method because our acquaintance with the type constantly tempted us to supple-

ment the literature and to react to available materials critically and constructively. We departed still further from our ideal of objectivity and aloofness in the Chimpanzee. This was inevitable, since our opportunities for acquaintance with the characteristics of this ape are equaled only by those of Köhler. Furthermore, and unfortunately for us, most of our recent observations on the chimpanzee, and indeed the major part of the results which have been obtained in the Primate Laboratory of Yale University during the past four years, at the time of writing, were unpublished. Finally, in case of the Gorilla we found ourselves the sole possessors of intimate acquaintance with the animal as subject of psychobiological experiments and therefore under necessity of writing chiefly from the point of view of our own observations.

Nevertheless, this work in intent is primarily historical and objective; secondarily, it is original and critical. Thus it is offered as an informational and bibliographic source for investigators, students, and lay readers whose curiosity may lead them into the paths of anthropoid life.

Our task proved unexpectedly complex, long, and difficult. Had we realized in advance how much time it would require and how long it would interrupt our experimental work with the anthropoid apes, we probably should not have undertaken it. Now that it is finished, we are relieved but also oppressed by a sense of inadequacy, for we realize how much better we could do in repetition. We dare not hope the work is free from serious errors, although every effort has been made to achieve accuracy as well as adequacy in statement, reference, and quotation.

Initially personal need impelled us to assemble titles and abstracts. For aid in the early stages in this task we are indebted to Miss Geraldine Stowell, who for several months assisted us in Washington, D. C. The work thus begun subsequently was carried forward, extended, and completed in New Haven during three years of strenuous endeavor by Miss Margaret S. Child, now Mrs. George A. Lewis. For bibliographic search, verification of records, abstracting numerous contributions and translating into English such French and Latin publications as were needed for our files or for quotation in the text, we make grateful acknowledgment to Mrs. Lewis. Without her efficient, skilful, technically admirable and ready ability, the completion of this work would have been long delayed even if its quality were not impaired. We cannot adequately express our gratitude for the coöperation of Mrs. Lewis or our admiration for her professional competency and the quality of her work.

For translations from the Spanish and Italian, unless otherwise credited, we indicate at once our indebtedness and gratitude to Miss H. Irene Corey and Dr. Donald K. Adams. Ada W. Yerkes abstracted many of the Dutch, German, and Latin contributions. She is responsible also, unless otherwise indicated, for all translations from the Dutch and for many from the German and Latin which we have quoted.

In the preparation of manuscript and illustration copy we have been greatly assisted by Mrs. Lewis, but to our secretarial helper, Mrs. Helen S. Morford, we are above all indebted for extremely accurate transcription of dictation and notes, copying, endless verification and checking of translations, quotations, titles, and

references, the critical correctional reading of manuscript, what seemed like interminable proofreading, and assistance in the preparation of index.

Obviously we are deeply indebted to the scientific resources of the world and to investigators, not only of our own day but throughout human history. Yet to our friends and colleagues in anthropoid research, and especially to Mrs. N. Kohts of Moscow, Doctors A. Calmette and R. Wilbert of Paris, Doctor J. H. McGregor of New York, Doctor Gerrit S. Miller, Jr., of Washington, Sir Arthur Keith of London, Doctor E. Reichenow of Hamburg, and Doctor W. Köhler of Berlin, our obligations are most numerous and important, and we therefore attempt thus to indicate our consciousness of the fact, our appreciation and gratitude.

Authorities of many of the leading zoölogical gardens of the world have generously coöperated by supplying us with information and advice. Because of the preëminent value of their assistance we especially mention and return thanks to Director C. Emerson Brown and Doctor Herbert Fox, of the Zoölogical Garden of Philadelphia; Superintendent R. I. Pocock and Doctor P. Chalmers Mitchell, of the Zoölogical Society of London; Doctor Ludwig Heck, of the Zoölogical Garden of Berlin; Doctors William T. Hornaday and W. Reid Blair, of the Zoölogical Society of New York; the late Mr. N. Hollister, of the National Zoölogical Park, Washington, D. C.; Doctor A. S. Le Souef, of Sydney; Doctor C. Kerbert, of Amsterdam, and Doctor J. Buttikofer, of Rotterdam.

Our large collection of still and motion pictures of anthropoid apes has been importantly supplemented and the value of the illustrations in the book thus greatly enhanced through the kindness of Messrs. F. W. Bond, of the Zoölogical Society of London; E. R. Sanborn, of the Zoölogical Society of New York; Newton Hartman, of the Zoölogical Garden of Philadelphia, and G. Krause, The Hague. From each of these experts in animal photography we have borrowed incomparably interesting and scientifically valuable photographic copy. It is a pleasure to acknowledge their courteous coöperation as well as their skill and generosity. For illustrative material we desire to make acknowledgment also to Mrs. Rosalia Abreu, Doctor Harold C. Bingham, Doctor Louis Boutan, Mr. J. L. Buck, Miss Alyse Cunningham, Mr. Herbert Lang, Mr. N. E. Lewis, Dr. G. Elliot Smith, Mrs. R. A. Spaeth; American Museum of Natural History, New York; Century Company, New York; Bibliographisches Institut, Leipzig; Julius Springer, Berlin; Oxford University Press; Société Linnéenne de Bordeaux; Natural History Society of Bombay; Museum d'Histoire Naturelle, Paris; and the editors and publishers of Comparative Psychology Monographs, Genetic Psychology Monographs, and the Proceedings of the Zoölogical Society of London.

Naturally our historical research has depended primarily on library facilities and resources. It is indeed a pleasure to state that the intelligent, efficient, and cheerful coöperation of the staff of the Library of Yale University has set for our experience a new standard of library service. Emphatically we are appreciative of this assistance and of the spirit in which it was rendered. If we feel any regrets because of the completion of our prolonged historical research it will be on account of the partial, and we hope temporary, discontinuance of this coöperative relation. The resources of the Yale Library we were enabled to supplement perfectly by

loans from the Library of Congress, Army Medical Library, Library of the American Museum of Natural History, and the Library of Harvard University.

Likewise the staff of the Yale University Press has acquainted us with a new standard of skill and efficiency in the conversion of manuscript into letterpress. Coöperation with the Press from first to last in the manufacture of this volume has been delightful. If there are errors or artistic defects in the book we suspect that the fault lies with the authors, not the publishers. At any rate, we have profound respect for the latter's acquaintance with their business, their mode of conducting it, and their uniformly courteous and constructive relations with authors.

Except for the support of one or another aspect of our long-continued task of anthropoid research by the Carnegie Institution of Washington, the Rockefeller Foundation, the Laura Spelman Rockefeller Memorial, the Institute of Psychology, Yale University, and the sympathetic encouragement and assistance of our colleagues, locally and throughout the scientific world, we certainly could not have gone forward steadily to the completion of our historical study and the presentation of this informational handbook. To all, our sincere and hearty thanks.

THE AUTHORS

New Haven, Connecticut
March 23, 1929

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Buffon, 1766, vol. 14.

PART I. HISTORICAL

CHAPTER ONE

ANCIENT KNOWLEDGE OF THE ANTHROPOID APES

WHAT fascination of retrospect and revery if, to thousands of generations, one could marshal his ancestors for familiar salutation and inspection. A hundred generations pass, and one views with popping eyes forbears of Aristotelian times; another hundred, and with bated breath one gazes on folk who have left scant record in artifact or rock; barely another hundred, and one's historical orientation fails. A thousand pairs pass, and the sense of understanding, sympathy, and kinship has markedly diminished. Would the procession sooner or later bring each of us face to face with a direct ancestor so apelike that he might be mistaken for, or identified with, the chimpanzee, gorilla, or orang-outan?

Study of the form, activities, and creations of existing anthropoid apes may not answer the question, but combined with paleontological research, into human, prehuman, anthropoid, and pre-anthropoid existence, it should enable us partially to trace our descent and to construct our family tree. Students of psychobiology are in the midst of diligent and exciting search for anthropoid information. The opportune moment to attempt the coördination and interpretation of diverse assemblages of facts has not arrived. Consequently it is our immediate task, as writers of this book, to inquire particularly and minutely, aided by historical documents and our own powers of observation, into the life history and action-system of the anthropoids. We shall endeavor to picture clearly in psychobiological terms the active life of those infrahuman primates which structurally, as well as psychologically and socially, resemble us most closely. We shall not write imaginative genetic history, nor shall we theorize or generalize from fragmentary knowledge.

It is significant in connection with our task that for thousands of years, and probably tens of thousands, anthropoid apes have shared the earth with man without

the development of mutually agreeable and helpful social relations. No infrahuman primate, least of all the great ape, has been thoroughly domesticated. Neither has man come into intimate sympathetic touch with the lives of these creatures, except as they or he were held in captivity. Slave makers though we be, the other primates have escaped servitude. As captives they seldom play other rôles than those of pet and entertainer.

Although we cannot with accuracy portray the procession of our ancestors, we may with fair assurance mark the dawn and trace the growth of our knowledge of the anthropoid apes. Such a historical survey, brief and orientational, may serve as introduction to this systematic account of anthropoid behavior.

In the ancient cultures of Europe, Asia, and Africa are preserved records of certain infrahuman primates. Whether anthropoid or not it often is impossible to decide. Names, incidents, adventures, items of natural history, pictorial and verbal descriptions, supposedly referring to apes, monkeys, baboons, or other primates, are our legacy. Precious though these fragments must seem to the erudite historian and the specialist in human origins, they are peculiarly unsatisfactory to us because it is seldom possible to identify the type of animal in question. Names there are, but without exhibits attached; descriptions abound, but they are too meager or inexact to lead to certain identification. What at first impresses one as valuable information turns out finally to be scarcely more than the appearance of fact.

That several kinds of infrahuman primate have been known for upward of three thousand years at least is well attested by historical evidences; but that any of the four existing types of anthropoid ape—gibbon, orang-outan, gorilla, chimpanzee—were among them is extremely doubtful. By presenting a few examples of these ancient descriptive references we shall hope to exhibit their quality and value, while thereby suggesting explanation for the brevity of our discussion of the subject. In this work, devoted as it is to a statement of what is definitely known about anthropoid behavior, it seems more fitting to sketch the history of the growth of knowledge than to describe it fully and in detail; to refer the reader to the most satisfactory historical summaries and the most valuable sources instead of reproducing, perhaps for the hundredth time, what is easily available to anyone who cares to command the resources of our great libraries.

As we have examined the abundant but widely scattered literature of our subject, we have been deeply and unfavorably impressed by the uncritical copying, quoting, or paraphrasing of author by author. Superstitions, surmises, rumors, accidental and unverifiable observations, inferences, and unwarranted conclusions, have been repeated through the centuries. As one contemplates the utter wastefulness and the negative intellectual value of this procedure one is depressed and comes to feel that a worth-while task is better once well done than a hundred times imperfectly. The hundreds of descriptions, discussions, and re-discussions of anthropoid life and behavior which we have examined make us feel that it is a pity man should write so much, while observing, reflecting, and criticizing himself and his work so little.

But we must enter upon our adventure in the realm of relative ignorance. Some centuries before the present era it was written:

> For the king's ships went to Tarshish with the servants of Huram: every three years once came the ships of Tarshish bringing gold, and silver, ivory, and apes, and peacocks. (Holy Bible, II Chron. 9. 21.)

Apes, yes, but what ape is meant? May we infer that certain African types were referred to, and, if so, were they anthropoid apes, monkeys, or baboons? Who can tell?

In the fifth century, B.C., one Hanno, a Carthaginian admiral, is supposed to have made a voyage of exploration and colonization along the west coast of Africa. His description, as it appears in the translated

Periplus, contains the following notable passage:

On the third day after our departure thence, having sailed by those streams of fire, we arrived at a bay called the Southern Horn; at the bottom of which lay an island like the former, having a lake, and in this lake another island, full of savage people, the greater part of whom were women, whose bodies were hairy, and whom our interpreters called Gorillæ. Though we pursued the men, we could not seize any of them; but all fled from us, escaping over the precipices, and defending themselves with stones. Three women were however taken; but they attacked their conductors with their teeth and hands, and could not be prevailed on to accompany us. Having killed them, we flayed them, and brought their skins with us to Carthage. We did not sail further on, our provisions failing us. (Hanno, *Periplus,* translated from the Greek by Falconer, 1797, pp. 13-15.)

Is this the first record of the gorilla, today so called, or is the reference to some other creature? Authorities differ: some say human pygmies or dwarfs; some, chimpanzees; some, an extinct race of African apes; and some, gorillas. To us the presumption seems slightly in favor of the chimpanzee or an extinct type of anthropoid. We, therefore, are unwilling to date the discovery of that largest of manlike apes, the gorilla, from the time of Hanno.

Shortly after the adventure of Hanno, and in the fourth century, B.C., Aristotle, industrious gatherer of naturalistic information, offered in his famous history of animals a description of the ape which marks the beginning of our historical adventure.

Some animals share the properties of man and the quadrupeds, as the ape, the monkey, and the baboon. The monkey is a tailed ape. The baboon resembles the ape in form, only that it is bigger and stronger, more like a dog in face, and is more savage in its habits, and its teeth are more dog-like and more powerful.

Apes are hairy on the back in keeping with their quadrupedal nature, and hairy on the belly in keeping with their human form—for, as was said above, this characteristic is reversed in man and the quadruped—only that the hair is coarse, so that the ape is thickly coated both on the belly and on the back. Its face resembles that of man in many respects; in other words, it has similar nostrils and ears, and teeth like those of man, both front teeth and molars. Further, whereas quadrupeds in general are not furnished with lashes on one of the two eyelids, this creature has them on both, only very thinly set, especially the under ones; in fact they are very insignificant indeed. And we must bear in mind that all other quadrupeds have no under eyelash at all.

The ape has also in its chest two teats upon poorly developed breasts. It has also arms like man, only covered with hair, and it bends these legs like man, with the convexities of both limbs facing one another. In addition, it has hands and fingers and nails like man, only that all these parts are somewhat more beast-like in appearance. Its feet are exceptional in kind. That is, they are like large hands, and the toes are like fingers, with the middle one the longest of all, and the under part of the foot is like a hand except for its length, and stretches out towards the extremities like the palm of the hand; and this palm at the after end is unusually hard, and in a clumsy obscure kind of way resembles a heel. The creature uses its feet either as hands or feet, and doubles them up as one doubles a fist. Its upper-arm and thigh are short in proportion to the fore-arm and the shin. It has no projecting navel, but only a hardness in the ordinary locality of the navel. Its upper part is much larger than its lower part, as is the case with quadrupeds; in fact, the proportion of the former to the latter is about as five to three. Owing to this circumstance and to

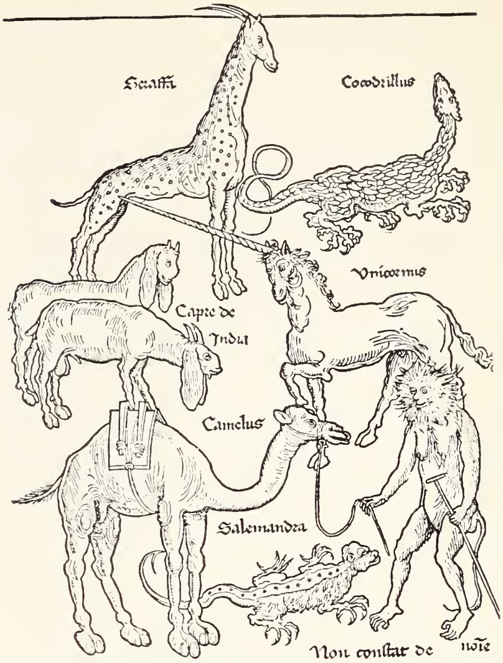


Fig. 1. Animals, including a manlike creature, from Briedenbach's *Travels,* 1486. Pierpont Morgan Library.

the fact that its feet resemble hands and are composed in a manner of hand and of foot: of foot in the heel extremity, of the hand in all else—for even the toes have what is called a "palm":—for these reasons the animal is oftener to be found on all fours than upright. It has neither hips, inasmuch as it is a quadruped, nor yet a tail, inasmuch as it is a biped, except by the way that it has a tail as small as small can be, just a sort of indication of a tail. The genitals of the female resemble those of the female in the human species; those of the male are more like those of a dog than are those of a man. (Aristotle, *Historia Animalium,* translated by Thompson, 1910, Bk. II, 8.)

Assured of the trustworthiness of Aristotle, we may conclude from his description that the ancients, possibly of twenty-five hundred years ago, were familiar with four groups of primate: man, tailless apes, tailed monkeys, and baboons. Which, if any, of the anthropoid apes were known, remains unanswered. Aristotle's description might well have been based on the magot of Cuvier, now the Barbary ape, a tailless form once grouped with the apes, as contrasted with the monkeys, but not an anthropoid ape. That Aristotle's sources acquainted him with the existence and nature of gibbons or of any one of the three man-like apes is highly improbable. Nevertheless, his statements are peculiarly important to us as marking a step toward the taxonomic adequacy of description. We are not convinced, however, that his historical sources, or his personal observation, supplied data for reliable description of any one of the anthropoid apes.

Early in the Christian Era, and some four centuries after Aristotle, Pliny the Elder repeated the task of gathering into a single work current knowledge of the primates. Unlike Aristotle, he included also sealing wax and kings! Undoubtedly Pliny drew abundantly from Aristotle and Juba, but naturally he commanded also varied and more recent sources of information. His remarkable history of the world makes interesting reading, if one gives his sense of humor rein and is not too squeamish about matters of fact and fitness. Truly the work is an odd mingling of fact and fancy.

Among the Westerne mountaines of India the Satyres haunt, (the countrey wherein they are, is called the region of the Cartaduli) creatures of all other most swift in footmanship: which one whiles run with all foure; otherwhiles upon two feet onely like men: but so light-footed they are, that unlesse they be very old or sicke, they can never bee taken. *Tauron* writeth, That the Choromandæ are a savage and wild people: distinct voice and speech they have none, but in steed thereof, they keepe an horrible gnashing and hideous noise: rough they are and hairie all over their bodies, eies they have red like the houlets, and toothed they be like dogs. *Eudoxus* saith, That in the Southerne parts of India, the men kind have feet a cubite long, but the women so short & small, that thereupon they be called Struthopodes, *i.* sparrow footed. *Megasthenes* is mine author, that among the Indian Nomades there is a kind of people, that in steed of noses have only two small holes, and after the manner of snakes have their legs and feet limmer, wherewith they crawle and creepe, and named they are Syrictæ. (Plinius, *Natural History,* translated by P. Holland, 1601, p. 156.)

Those interpreters of this passage who are eager to discover anthropoid apes in ancient writings identify "Satyres" as gibbons, "Choromandæ" as baboons, and "Syrictæ" as orang-outans. Possibly they are right, but to follow them certainly requires a robust will to believe.

In the following passage we note varieties of observation which are reported throughout the centuries with surprisingly little variation or supplementation. Verily, the pathway to exact knowledge, even of such impressive objects as apes, seemeth difficult.

All the kind of these Apes approach neerest of all beasts, to the resemblance of a mans shape: but they differ one from another in the taile. Marveilous craftie and subtle they be to beguile themselves: for by report, as they see hunters doe before them, they will imitate them in every point, even to besmeare themselves with glew and birdlime, and shoo their feet within grins and snares, and by that meanes are caught. *Mutianus* saith, that he hath seene Apes play at chesse and tables; and that at first sight they could know nuts made of waxe from others. (Plinius, *op. cit.,* p. 231.)

Whereas in pre-Christian writings the descriptions seem oftenest to apply to African primates, in Pliny, and for some cen-

turies after him, Asiatic forms are more frequently mentioned. One can scarcely believe that in the time of Pliny any of the types of anthropoid ape were entirely un-

Fig. 2. Representation of capture of apes in the act of putting on boots. From Pigafetta, Latin edition, 1598. Drawn by DeBry brothers.

known. Indeed, the evidences convince us that gibbons, orang-outans, chimpanzees, and possibly also gorillas, had been heard of by many cultured persons through the reports of collectors, travelers, and explorers. Possibly some persons with interest in medicine or natural history had seen specimens. But in any event they were so meagerly and inaccurately known as to render identificational descriptions impossible. Confusion of types of infrahuman primate among themselves, and of them with mythical or imperfectly known human groups, was prevalent and continued so for several centuries.

After the work of Pliny the Elder, yet another century elapsed and that great pioneer in medical science and art, Galen (130-200? A.D.), began to search the world for anatomical materials. Although his works do not, so far as we have been able to learn, make specific reference to the types of primate dissected and described, the anatomists Tyson and Camper infer from his writings that he was familiar with certain monkeys, baboons, the orang-outan, and possibly also the gibbon. The latter, however, Camper questions.

Tyson, who in 1699 described the chimpanzee under the name "orang-outang," remarks:

Galen formerly dissected *Apes* and *Monkeys,* and recommended to his Scholars the frequent *Anatomizing* them, as useful for the attaining the Knowledge of the Structure of the Parts in *Humane* Bodies. Had he met with our *Animal,* it had served his turn much better: Nor had he been liable to some Mistakes, which *Vesalius* charges him with, since in so many Parts, the *Orang-Outang* imitates a *Man,* more than *Apes* and *Monkeys* do. (Tyson, 1699, preface.)[1]

In illuminating comment on grounds of confusion of anthropoid types by the ancients, Tyson continues:

This great Agreement, which I observed between the *Orang-Outang,* and a *Man,* put me upon considering, whether it might not afford the Occasion to the Ancients, of inventing the many Relations, which they have given us of several *sorts* of *Men,* which are no where to be met with but in their Writings. For I could not but think, there might be some Real Foundation for their *Mythology;* which made me more strictly enquire into their Records; and examining them, I always found something new, that insensibly lead me on far beyond what at first I intended: and if I do not deceive my self, I have at last gained a clearer Light in these Matters, than any that has hitherto appeared.

For what created the greatest difficulty, was their calling them *Men,* but yet with an Epithet for distinction sake; as the . . . *Wild Men,* the *Little Men,* the *Pygmæan Men,* the *Black Men,* the *Men* with *Dogs Faces,* &c. yet at the same time I find that they made them . . . *Wild Beasts;* and if so, no doubt but they were of the *Quadru-manus* kind; *i.e.* either *Apes* or *Monkeys.* And such were likewise the *Satyrs,* the *Fauni, Pan, Ægipan, Sylvanus, Silenus,* and the *Nymphæ,* as also the *Sphinges* of the Ancients.

But so many *Romances* have been made about them, that not only *Strabo* formerly, but the most noted Men of Learning of late, have looked upon them as meer Fictions of the *Poets,* and have utterly denied them any real Being. *Homer's Geranomachia* therefore, or *Fight* of the *Cranes* and *Pygmies,* I have rendered a probable Story. *Aristotle's* assertion of the being of *Pygmies,* I have vindicated from the false Glosses of others. The Conjectures of other Learned Men about

[1] Reference is by date of publication to general bibliography at end of volume.

them, I have examined: And by what I have said in the following *Philological Essay,* I think I have fully proved, that there were such *Animals* as the Ancients called *Pygmies, Cynocephali, Satyrs,* and *Sphinges;* and that they were only *Apes* and *Monkeys.* (Preface.)

Throughout this passage orang-outan must be translated chimpanzee, since it is certain from Tyson's description of source and anatomical characters that he refers to the smaller of the African anthropoid apes.

Galen noted the greater anatomical similarity between ape and man than between baboon and man.

An Ape is the most like a Man of any Quadruped: In the Viscera and the Muscles, and in the Arteries, and Veins and Nerves, because 'tis so in the structure of the Bones. For 'tis from their make, that it walks on two Legs, and uses its fore-limbs as Hands. It hath the largest Breast of any Quadruped, and Clavicles or Collarbones like a Man, and a round Face, and a small or short Neck. (Galenus, *D'Anat. Administr.* lib. 1, cap. 2, p.m. 26. Our quotation is from Tyson, 1699, p. 15.)

Writing in 1779, Camper, a pioneer in comparative anatomy, remarks:

Being Professor of Natural Philosophy, Anatomy, Surgery, and Physic, in the University of Franeker in Friesland, I soon perceived the impossibility of understanding the most precious and valuable works of the immortal Galen (especially his anatomical works) without dissecting monkies, to compare his exact descriptions with. I got for that purpose, in the year 1754, a Cynocephalus, and was charmed to find the exactness of almost all Galen's descriptions. The organ of speech puzzled me, nevertheless, very much, and I was not able to explain his observations, so as to satisfy myself in this animal: I was obliged, therefore, for want of other apes, to delay my researches to another opportunity, which, however, I did not meet with till I came to Amsterdam, where I settled in the year 1755. . . .

As Galen not only dissected the *Cebi,* or the Cynocephalus, who are all of the tailed or *caudati* kind, but the *Pithecos* or ape without a tail; and as the celebrated Dr. Tyson had found the organ of voice so similar to that of men in his *Pigmy,* I endeavoured to get one from the East Indies. For this purpose I offered a good sum of money to my correspondents to have a well-preserved Orang Outang, because none were to be met with in any collection of Natural History in Holland. (Camper, 1779a, pp. 140-141, 144.)

Camper goes on to report success in obtaining specimens of the Asiatic orang-outan and also of what he calls the Angolese Orang, which is known to us as the chimpanzee. His principal conclusion, as far as Galen's knowledge of the anthropoids is in question, is thus stated:

The organs of voice of the Angolese Orang, dissected by Tyson, are very different from those of the *Pithecos* which I dissected 1777. This one had the *os hyoides* like all the *papiones* or *sphinges,* &c.; the *epiglottis* perforated as in fig. 3 and 4 and therefore different from Galen's description, and from Tyson's, who makes no mention at all of the one, nor of the two bags which Galen describes, and which I found in the real Orang of Borneo; not only in one specimen, but in five, which I have dissected for that purpose.

To return to Galen; I am very apt to think that he dissected an Asiatic Orang, from which he took his description of the ventricles *a latere lingulæ,* at the sides of the *epiglottis.* (Camper, 1779a, p. 147.)

The opinions of Tyson and Camper, based as they are on first-hand acquaintance with the structure of a manlike ape (either chimpanzee or orang-outan) and on intimate knowledge of the writings of Galen, certainly command serious consideration and confidence. We are impelled thereby to date definitely scientific acquaintance with an anthropoid ape from the time of Galen and to assume that he described exactly and in detail certain structures and anatomical characteristics of at least one type of existing anthropoid ape.

Our exhibits and comment on ancient knowledge of the primates should acquaint the reader with its nature and especially its peculiar limitations. Much evidently was known uncertainly and imperfectly. But instead of a consistent descriptive fabric of verifiable information, our predecessors of the pre-Christian Era possessed fragments which they variously fitted together according to current rumor, superstition, and immediate purpose.

Other and abler historians and interpreters of evidence than we have given lavishly of their time and skill in the study

of this subject. It, therefore, is both our good fortune and our pleasure to be able to refer the reader to their reasonably systematic, complete, and detailed discussions. As together giving an excellent general account of ancient knowledge of infrahuman primates we should recommend Gesner (1551), Aldrovandi (1637), Tyson (1699), Hoppius (1760), Camper (1779, complete works 1803), Lichtenstein (1791), de Blainville (1840), and Huxley (1863).

Lichtenstein is the author of a scholarly philological essay in which he attempts to discover the nature and extent of the ancients' knowledge of the primates, and to relate their names for the different types to the nomenclature of his own day and especially to that of Linnaeus. The best review of the entire subject which we have found in English is that of de Blainville, who, unlike most writers on the topic, was familiar with the important publication of Lichtenstein and several times refers to it. Huxley examines the subject with characteristic insight, feeling for values, and clarity. His essay "On the natural history of the man-like apes" continues to be an excellent introduction.

CHAPTER TWO

KNOWLEDGE OF THE ANTHROPOIDS THROUGH THE MIDDLE AGES TO THE END OF THE SEVENTEENTH CENTURY

FROM the second century to the sixteenth, acquaintance with the primates seems chiefly to have perished with its possessors. Few written documents or other easily interpretable evidences are available to us, and in such as we have we find no additional information about the anthropoid apes.

Marco Polo, in the thirteenth century, mentioned Asiatic creatures which may have been anthropoids.

> It should be known that what is reported respecting the dried bodies of diminutive human creatures or pigmies, brought from India, is an idle tale, such pretended men being manufactured in this island in the following manner. The country produces a species of monkey, of a tolerable size, and having a countenance resembling that of a man. Those persons who make it their business to catch them, shave off the hair, leaving it only about the chin and those other parts where it naturally grows on the human body. They then dry and preserve them with camphor and other drugs, and having prepared them in such a mode that they have exactly the appearance of little men, they put them into wooden boxes, and sell them to trading people, who carry them to all parts of the world. But this is merely an imposition, the practice being such as we have described; and neither in India, nor in any other country, however wild (and little known) have pigmies been found of a form so diminutive as these exhibit. (*The Travels of Marco Polo.* Translated by Marsden, 1818, p. 604.)

Possibly the "monkeys" thus used commercially were gibbons.

In his description of Kumari, a province in the extreme southern promontory of India, the same author writes:

> The country is not much cultivated being chiefly covered with forests, which are the abode of a variety of beasts, especially apes, so formed and of such a size as to have the appearance of men. There are also long-tailed monkies, very different from the former in respect to magnitude. (*Op. cit.*, p. 683.)

The historical value of Marco Polo's references to primates is slight; their scientific value, negligible. They have been mentioned here as harbingers of the dawn or revival of scientific interest in our subject.

During the sixteenth century Konrad Gesner, impatient of scholasticism, imbued with the spirit of inquiry, and learned in the biology of his time, assembled in a truly remarkable compilation all available information about the Simia. Drawing intelligently and freely from the writings of such historical beacons among the ancients as Aristotle, Albertus Magnus, Pliny, and Galen, Gesner (1551) describes the variety, distribution, habitat, appearance, mode of life, and mental traits of the known primates. For the modern student Gesner's record is of the utmost interest, since it is an admirable account of the knowledge of the ancients, a vivid picture of the credulity, superstition, and fancifulness of the Middle Ages, and a determined effort to distinguish the true from the false. His representation of an anthropoid ape, reproduced as figure 3, gives one a startling impression of the inaccuracy and inadequacy of anthropoid knowledge at that time. (Gesner, *Historiae Animalium.* Edition of 1602, I, 847-871.)

Although historically the work of Gesner seems to us of very high value, it contributes almost nothing to our knowledge of the types of anthropoid ape and their life.

Belonging in the period with Gesner, and writing almost simultaneously, is Filippo Pigafetta (1591) who in his description of the African Congo reports the observations of a Portuguese sailor, Duarte Lopez. Hartmann (1885) states that this author

describes the chimpanzee, but we have failed to discover in Pigafetta justification of the inference.

Of "munkies" and "babownes" one Richard Jobson, shortly after the time of Pigafetta, wrote entertainingly and even correctly, except for confusion of types. For whereas the introductory portion of the account of the "babowne" conforms to our knowledge of that primate, the latter part seems rather to apply to the chimpanzee. In support of this opinion we quote a few sentences:

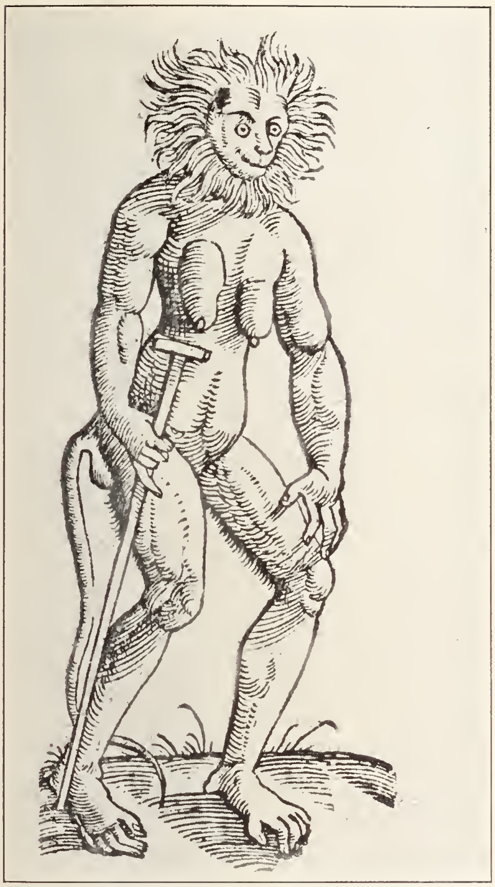


Fig. 3. A figure from Gesner, 1602, vol. 1, who presumably borrowed it from Briedenbach.

But to speake of the Babowne, I must say, it is a wonderfull thing, to observe a kind of common wealth that is amongst them; they have none but their owne kind together, and are in heardes, of three or foure thousand in a company; as they travell, they goe in rancke, whereof the leaders are certaine of the greater sort, and there is as great, and large of them, as a Lyon, the smaller following, and ever now and then as a Commaunder a great one walkes; the females carry their yong under their bellies, except shee have two, and then one under, the other above. In the rear comes up a great company of the biggest sort, as a guard, against any persuing enemy, and in this manner doe they march along: they are very bold, and as we passe in the river, when we come neare their troupes, they will get up into the trees, and stand in gaze upon us, and in a kind of collericke humour the great ones will shake the trees, and with his hands clatter the boughes in that fashion, as it doth exceed the strength of a man, to doe the like, barking, and making a noyse at us, as if they were much offended, and in this manner, many times they will follow us along, and in the night time, where wee ride at an ancker take up their stands, or lodgings on the mountaine toppes, or on the trees that are above us, whereas we heare their government: for many times in the night you shall heare such a noyse of many of their voyces together, when instantly one great voyce exalts it selfe, and presently all are hush, and the noyse is dasht, so as we were wont to say, Maister Constable speakes; likewise when wee are a shore and meete with these troupes, on a sudden the great ones will come forward, and seeme to grin in our faces; but offer up a gunne, and away they packe. (Jobson, *The Golden Trade,* 1623. Quotation from new edition by Charles G. Kingsley, 1904, pp. 183-185.)

And later:

And lastly let mee tell you that wee have seene in the desert places they use, trees and plants, wound and made up together in that artificiall manner, and wrought together with that thicknes over head, to keepe away the sun, and shade the ground, which hath bin beaten, & smoothed under neath, and all things in the manner and shape of an excellent arbour, which place they have only used, and kept for their dancing and recreation; that no man living that should have come by chance, and seene the same, without knowledge of these unlucky things, but would have confidently supposed, it had, and must have beene the handy worke of man; which some wayes confirmes the opinion the Spaniard holds of them, and doth not sticke to write it, that they are absolutely a race and kind of people, who in regard they will not bee brought to worke, and live under subjection, refuse to speake, and so he reports of them. (*Op. cit.*, pp. 185-186.)

Certain authorities, notably Hartmann (1885, p. 4), date definite knowledge of the gorilla from the report of Battell, who,

taken prisoner by the Portuguese in 1559, spent several years in Africa. The narrative of Battell was published in 1613 in *Purchas his Pilgrimes,* but the passage of particular interest in this connection is not found in editions prior to that of 1625. Because of its unique historical significance we quote Battell's description of the African anthropoid apes, and also the editor's comment.

The Woods are so couered with Baboones, Monkies, Apes, and Parrots, that it will feare any man to trauaile in them alone. Here are also two kinds of Monsters, which are common in these Woods, and very dangerous.

The greatest of these two Monsters is called, *Pongo,* in their Language: and the lesser is called, *Engeco.* This *Pongo* is in all proportion like a man, but that he is more like a Giant in stature, then a man: for he is very tall, and hath a mans face, hollow eyed, with long haire vpon his browes. His face and eares are without haire, and his hands also. His bodie is full of haire, but not very thicke, and it is of a dunnish colour. He differeth not from a man, but in his legs, for they haue no calfe. Hee goeth alwaies vpon his legs, and carrieth his hands clasped on the nape of his necke, when he goeth vpon the ground. They sleepe in the trees, and build shelters for the raine. They feed vpon Fruit that they find in the Woods, and vpon Nuts, for they eate no kind of flesh. They cannot speake, and haue no vnderstanding more then a beast. The People of the Countrie, when they trauaile in the Woods, make fires where they sleepe in the night; and in the morning, when they are gone, the *Pongoes* will come and sit about the fire, till it goeth out: for they haue no vnderstanding to lay the wood together. They goe many together, and kill many *Negroes* that trauaile in the Woods. Many times they fall vpon the Elephants, which come to feed where they be, and so beate them with their clubbed fists, and pieces of wood, that they will runne roaring away from them. Those *Pongoes* are neuer taken aliue, because they are so strong, that ten men cannot hold one of them: but yet they take many of their young ones with poisoned Arrowes. The young *Pongo* hangeth on his mothers bellie, with his hands fast clasped about her: so that, when the Countrie people kill any of the femals, they take the young one, which hangeth fast vpon his mother. When they die among themselues, they couer the dead with great heapes of boughs and wood, which is commonly found in the Forrests.

The editor, Purchas, comments as follows:

The *Pongo,* or Giant-ape. He told me in conference with him, that one of these *Pongos* tooke a *Negro* Boy of his, which liued a moneth with them. For they hurt not those which they surprise at vnawares, except they look on them, which hee auoyded. He said, their highth was like a mans, but their bignesse twice as great. I saw the *Negro* Boy. Their strength. What the other Monster should be, he hath forgotten to relate: and these papers came to my hand since his death, which otherwise in my often conferences I might haue learned. Perhaps he meaneth the *Pigmey Pongo*-killers, mentioned. (Purchas, *Hakluytus Posthumus, or Purchas his Pilgrimes,* 4th ed., 1625, II, 981-982.)

Was Battell acquainted with the gorilla? We think he was, for although it is possible that *Pongo* refers to the adult chimpanzee and *Engeco* to the young of this ape, Battell's statements about the size and appearance of the *Pongo* more nearly fit the gorilla than the chimpanzee; and, furthermore, his failure to describe the "smaller monster," the *Engeco,* may indicate its relatively greater abundance and its less impressive character. It is our opinion that this adventurer either saw or learned from the natives of the existence of gorillas and chimpanzees. But even if we are correct in this surmise, we grant that knowledge of the African anthropoids was not advanced much by the Battell report.

The Italian naturalist Ulisse Aldrovandi, in the latter half of the sixteenth century, undertook to assemble, in a *magnum opus,* the natural history of his times. A volume which he published in 1637 contains a notable chapter on Simia, in which, following Gesner and borrowing freely from him, the author considers historically and in the spirit of his times, nomenclature, types and classifications, structure, nature and habitat, foods and habits of life, sexual behavior and reproduction, modes of capture, likes and dislikes, diseases, problems, proverbs, symbols, dreams, stories, graphic representations, and varied curious and interesting miscellany. So far as we know, this work has not been translated from the Latin. Like Gesner's great work, it is an eminently useful assembling and ordering of information. Those with taste for the

odd in history will find it fascinating, whereas the biologist who comes to it without historical background and appreciation of the characteristics of the medieval mind and its information will be dismayed by its seeming chaos and credulity. In no other single work, unless it be that of Gesner, can one find so many imaginative stories of the infrahuman primates and other curiosities of natural history. Aldrovandi failed utterly if he tried to discriminate between the true and the false, for his book is not a whit more reliable than are those of certain earlier writers.

The following brief quotation does full justice to the style, content, and evaluations of Aldrovandi's description. With difficulty we resist the temptation to offer more.

According to Porta, the monkey leaps back on seeing a tortoise, even though bound. Erasmus, in a dialogue on friendship, tells how a boy on whose head was placed a tortoise shell, took a monkey in his arms, but the latter, about to hunt for lice in the boy's head, perceived the shell and jumped back with such horror that he nearly died. Hactenus tells of a monkey surrounded by a circle of snails and afraid to touch them. (Aldrovandi, *De Quadrupedibus Digitatis Viviparis*, 1637, p. 232.)

An anthropoid ape called the Indian Satyr (*Satyrus Indicus*) in 1641 was described by Nicolaas Tulp with adequate detail and accuracy to permit its identification as a chimpanzee. The specimen was brought from Angola and presented to Frederic Henry, Prince of Orange.

Following his general description of the appearance and behavior of this ape, Tulp continues:

So nothing more like this one's imitation was represented by the Satyrs of old. Which Plinius (Bk. VII, chap. 3) describing to his readers, wrote expressly "there is an animal, a quadruped, in the tropical mountains of India, a most pernicious one; with a human figure, but with feet of a goat; and with a body hairy all over. Having none of the human customs; rejoicing in the shadows of the wood; and fleeing from intercourse with men."

From these characteristics the Satyr of the blessed Hieronymus differs somewhat perhaps: yet it agrees nevertheless, with the figures of the Poets. There was, he says: "a man with nostrils turned inward and a rough face with horns; with the extremes of the body ending in feet of goats." Which same form the poets expressing most

Fig. 4. "Orang-outang," known to have been a chimpanzee. From Tulp, 1641.

clearly, call their Satyrs lascivious, shameless, two-formed, two-horned, and with the wanton inclinations of the woods.

Which epithets of the ancients, if you explore with the level of truth, you will see were themselves not far wrong. (Tulp, *Observationum Medicarum*, 1641, Bk. III, chap. 56, p. 277.)

And later, after commenting on the false descriptions of the ancients, Tulp remarks:

He who diminishes this faith, easily falls upon the sharp rocks of false accusations: and weakens the authority of his history by differing from accepted opinion. Such injury formerly hissed, yet in the right way Herodotus endured, a writer, for the rest, not unbeautiful. From him therefore, as far as it could be done in so great shadows, Pliny culled out the best observations; and was

content to leave his satyr rather than the true one to posterity. But it was in the service of fame; and never can one freely retreat from opinions which have acquired age: nor from fables invented by the Poets. The coming of this Indian Satyr, perchance becoming famous, may disperse their dense fog. *It is difficult to please everyone.* (*Op. cit.*, pp. 278-279.)

From the illustration found on page 275 of Tulp's book (our figure 4), and labeled *Homo sylvestris,* Orang-outang, one may with difficulty decide whether it was drawn from a chimpanzee or an orang-outan. Happily in this instance we know that the writer had first-hand acquaintance with a living specimen of chimpanzee and that the artist must have been at fault.

We have given much attention to this author's contribution to knowledge of the anthropoid apes chiefly because his is the first obviously truthful, even if inaccurate, verbal and pictorial description of the chimpanzee. That he should have confused it with the orang-outan is neither surprising nor particularly disconcerting, since identification is possible.

The work of Tulp, nearly three centuries ago, marked definite and important changes in the character of anthropoid knowledge. Thereafter description became increasingly detailed and accurate, although for centuries confusion of types persisted.

Only a few years after publication by Tulp, Jacob Bontius wrote unmistakably of the Bornean orang-outan, albeit with such general description and inaccurate illustration that the identification of his subject depends primarily on its source and on his account of its appearance and behavior. Nevertheless Bontius, as truly representative of his times, is worthy of mention and quotation, if not also of censure for carelessness.

Using for a different type of great ape the names *Homo silvestris* and Ourang Outang which Tulp had applied to the chimpanzee, Bontius with delightful sarcasm remarks:

Goat-footed Satyrs, Sphinges, and frisky fauns. Not even boys believe in: Yet regard this wonderful monster with a human face, not only like the customs of man in speaking, but also in wetting his lips with weeping. (Bontius, *Historiae Naturalis,* 1658, Bk. VI, p. 84.)

Then following a reference to Pliny, he continues:

But yet what merits greater admiration, I myself have seen several and of both sexes walking erect, first that young female satyr (whose figure I here exhibit) hiding her secret parts with so great modesty from unknown men, and also her face with her hands (if one may speak thus), weeping copiously, uttering groans, and expressing other human acts so that you would say nothing human was lacking in her but speech. The Javanese say, in truth, that they can talk, but do not wish to, lest they should be compelled to labor: ridiculous, by Hercules. The name they give to it is Ourang Outang, which means a man of the woods, and they affirm that they are born from the lust of the Indian women, who mix with apes and monkeys with detestable sensuality.

Let boys believe, who have not yet to shave. (*Op. cit.*, p. 85.)

Fig. 5. Creature called "Ourang Outang," evidently a pilose woman. From Bontius, 1658.

The illustration which as figure 5 we

have taken pains to reproduce from what purports to be the first edition of Bontius' book, instead of from later reproductions which were more or less altered, convinces one that the artist's model was a pilose woman.

Especially worthy of remark is the critical attitude of Bontius toward the fantastic imaginings of many of the ancients. In this he and Tulp evidently were sympathetic.

Quoting with apparent approval certain earlier authorities whose facts we know to be few and whose descriptions grossly inaccurate, Nieuhoff refers to what may have been the gibbon. Except for the contribution of Athanasius Kircher which appears in his volume, we probably should not have thought to include the name of Nieuhoff in this chapter. This description from Kircher has marked human interest.

The Province *Fokien* hath an Animal perfectly resembling man, but longer arms, and all over hairy, called *Fese*, most swift and greedy after humane flesh, which that he may the better make his prey, he feigneth a laughter, and suddenly while the person stands listning, sieseth. There are also in *China* Apes and Baboons of a different kind, whereof some imitate Men, others Dogs and Cats, and are also tractable and docile to admiration, of which take Father *Roths* relation, he being an eye-witness. The King of *Bengala* in the year 1660 dispatched unto the Emperour of the *Mogores* a solemn Embassy, with many rich Presents, amongst which was a Triumphal Chariot drawn by two white horses wonderfully adorned with Gold and Gems; but that which was more worthy admiration, the Charioteer was no humane Creature, for a great Baboon guided the Reins with no small skill and dexterity, his Livery Cloak and Cap shining with Scarlet and Gold, the Champion, a great Mastive sitting on the highest seat as in a Throne of Majesty, decked and adorned with Gold and Jewels in so great splendour, that he looked upon himself as a Demi-god, and not a Dog; his Valets-de-chambre, Pages, and Lacquies, richly drest according to their place and office, were all Apes and Monkies, officiously attending round about him, who so well had learnt his lesson, that when any person of quality drew near, he not only performed due reverence, making low Congies, but his well instructed Life-guard did the like: which the Emperour beholding with great pleasure and admiration, caused a high Treatment to be prepared for them, where each had his own proper and peculiar Mess, where his Guests seated themselves with good order and gravity. This pleasant Comedy I saw acted in the Imperial Palace at Agra. (Nieuhoff, *An Embassy from the East-India Company, etc.*, 1669, pp. 91-92 of appendix.)

If our animal trainers surpass this achievement they do well! One suspects that gibbons or orang-outans, as well as monkeys, may have taken part in the pageant, and that the term baboon is used for some other than the animal now so designated.

We find in Olfert Dapper's description of Africa, vague references to a species of "Satyre" called by the Negroes "Quojas-Morrou" and by the Portuguese "Salvage." The description leaves us uncertain whether the gorilla or chimpanzee is meant, but the names and the following quotation convince us that Dapper had reference to the specimen of chimpanzee previously described by Tulp.

It was thirty or forty years ago that one of these animals was sent to Holland and presented to his Highness, Prince Frederick Henry. It was the size of a child of three years, but was easily twice as broad, being of a good carriage, strong, vigorous, and agile; for it lifted heavy articles and carried them from one place to another. (Dapper, *Description de l'Afrique*, 1686, p. 366. Originally published in Dutch in 1676.)

Progress toward the really useful and obviously consistent classification of animals was even slower following the Dark Ages than the accumulation of descriptive information. From the time of John Ray (1628-1705) it is reasonable to date the development of modern systematic zoölogy. He it was who, from the chaos of such enthusiastic compilers and prolific writers as Gesner and Aldrovandi, produced order. The publication of his *Synopsis Methodica Animalium Quadrupedum et Serpentini Generis* in 1693 marks the beginning of a new era for biology. Logical, consistent, and exact classification and nomenclature are absolutely essential conditions for the extension and refinement of knowledge of organisms. Already we have presented ample evidence that anthropoid references and descriptions which do not permit certain

identification are next to valueless. It is because principles of classification and an acceptable nomenclature were essential to the development of knowledge of the anthropoid apes that we dwell appreciatively on the work of John Ray.

Le Comte (1697, II, 361-364) offers very general descriptions of both types of Asiatic anthropoid, the orang-outan and the gibbon. If it were worth while we might mention several other references of slight historical importance which, while indicating acquaintance with one or other of the anthropoids, mark relatively slow progress in the extension of knowledge.

As the work of Ray set a fashion for zoölogy and aroused enthusiastic interest in taxonomy, that of Tyson, distinguished comparative anatomist, marked the beginning of exact and detailed description of anthropoid structure. It was Tyson's merit to work discriminatingly, critically, and painstakingly. To close this chapter with mention of the epochal contributions of Ray and Tyson is peculiarly fitting. The former contributed only indirectly, but significantly, to the progress of anthropoid knowledge, the latter directly and to an extraordinary extent.

In the foregoing chapter we had occasion to quote Tyson's opinion about Galen's use of anthropoid apes. Incidentally some of his ideas about the mythical character and confusion of ancient anthropoid lore were presented. We shall now attempt to characterize his "description of an orang-outang or pygmie."

Tyson's *Anatomy of a Pygmie* is by far the most important contribution to anthropoid knowledge prior to the eighteenth century. Widely and accurately acquainted with the writings of his predecessors, he was much more critical than they of mythical data, inspired by a love of research, experienced in dissection and anatomical description, and disinterestedly concerned in the promotion of learning. In the preface to his book he remarks:

And the *Orang-Outang* (whose *Anatomy* I here give) being a Creature so very remarkable, and rare; and not only in its External Shape, but much more in the Conformation of a great many of the inward *Viscera,* so much resembling a Man; I thought I could not be too particular, in

Fig. 6. "Orang-outang or Pygmie," actually an immature chimpanzee. From Tyson, 1699.

my Description of it; though to some, who have not a Tast of these Matters, I may seem prolix and tedious. (Tyson, 1699, preface.)

Clearly perceiving the prevalent confusion of primate types Tyson intelligently and earnestly endeavored to set things right. In this connection his own words are of interest:

That the *Pygmies* of the Antients were a sort of *Apes,* and not of *Humane Race,* I shall endeavour to prove in the following *Essay.* And if the *Pygmies* were only *Apes,* then in all probability our *Ape* may be a *Pygmie;* a sort of *Animal* so much resembling *Man,* that both the Antients and the

Moderns have reputed it to be a *Puny Race* of Mankind, call'd to this day, *Homo Sylvestris,* The *Wild Man; Orang-Outang,* or a *Man* of the *Woods;* by the *Africans Quoias Morrou;* by others *Baris,* or *Barris,* and by the *Portugese,* the *Salvage.* But observing that under these Names, they describe different *Animals;* for Distinction-sake, and to avoid Equivocation, I shall call the Subject, of which I am about to give the *Anatomy,* a *Pygmie,* from its Stature; which I find to be just the same with the Stature of the *Pygmies* of the Antients. *Tulpius* 'tis true, and *Bontius,* and *Dapper* do call it, *Satyrus.* And tho' I am of Opinion, that the *Satyrs* of the Antients were of the Ape, or rather *Monkey*-kind; yet for the Reasons alledged in the following *Essay,* I cannot think our *Animal* a *Satyr.* The *Baris* or *Barris,* which they describe to be much taller than our *Animal,* probably may be what we call a *Drill.* But I must confess, there is so great Confusion in the Description of this sort of Creature, which I find is a very large Family (there being numerous *Species* of them) that in Transcribing the Authors that have wrote about them, 'tis almost impossible but to make mistakes; from the want of their well distinguishing them. I shall endeavour therefore in my Account of this, so to discriminate it, that it may be easily known again, where-ever 'tis met with. Not that I think in a single Observation I can be so exact, but that I may be liable to make Errors my self, how careful soever I have been. (*Op. cit.,* pp. 1-2.)

That the "pygmie" of Tyson was a chimpanzee is evidenced by its source, Angola, in Africa, its skeleton, and the description of its appearance, anatomy, and behavior. Our author recognized discrepancies in the accounts of the orang-outan given by Bontius and Tulp and seriously doubted whether they were describing the same creature. Actually we know now that Tulp wrote of the chimpanzee (as did Tyson also) and Bontius of the orang-outan.

Although it does not particularly concern us as students of psychobiology, we are impelled to mention the conspicuous merit of Tyson's anthropometric and anatomical observations by contrast with those of most of his predecessors.

From the Dark Ages and the early period of the revival of learning and reawakening of interest in natural science, six names stand forth as associated with notable contributions to the literature on the infrahuman primates. They are: Gesner, Aldrovandi, Tulp, Bontius, Ray, and Tyson. Gesner and Aldrovandi supplied invaluable compilations of information, Ray prepared the ground for an absolutely essential taxonomy, and Tulp, Bontius, and Tyson made progress toward increasingly exact description of the behavior, appearance, and anatomy of chimpanzee and orang-outan.

CHAPTER THREE

PROGRESS OF ACQUAINTANCE WITH THE ANTHROPOID APES DURING THE EIGHTEENTH CENTURY

PRIOR to intimate acquaintance with the anthropoid literature we had planned to arrange our materials under types and to trace through the centuries the increase in knowledge of each in turn. As we proceeded with our task it became clear that this would necessitate far more repetition of reference and statement of fact than would a simple chronological presentation. In the foregoing chapter we have described typical or outstanding contributions in order of publication, but hereafter we shall occasionally depart from the chronological order in considering signal and temporally approximated studies of a given type, topic, or method of procedure. In so doing we shall sacrifice logical consistency to what we hope may prove the convenience of the reader, intelligibility, clarity, and brevity.

The farther we go in this historical survey the more sketchy it necessarily becomes and the fewer, relatively, the significant contributions which can be mentioned. In default of completeness of reference and review we have endeavored to indicate correctly trends of interest, discovery, and method. It has been impossible to present any considerable part of the factual content of publications. This material is more appropriate, however, in the later parts of the volume in which we deal in detail with scientific knowledge of each of the principal groups of anthropoid ape.

During the eighteenth century special zoölogical studies of the anthropoids became increasingly numerous. Previously, the contributions of lay writers of natural history, travelers, explorers, government agents, and those on special missions, had predominated. Perhaps the chief single cause for this radical change in the character of anthropoid studies was the growth of a vigorous interest in zoölogical taxonomy and resulting stimulation of observation of the external appearance and internal structure of animals. In any event the eighteenth century was far more important in its scientific progress than any previous period, and in it the second half, more significant by far than the first.

The influence on anthropoid knowledge of the development of taxonomy or systematic zoölogy demands further comment. Following the stimulating work of Ray at the close of the seventeenth century, there appeared during the eighteenth century three notable figures: Linnaeus, Buffon, and Cuvier. About each of these builders of zoölogy gathered disciples, critics, and independent followers. We may mention only a few of the train who as classifiers, naturalists, or both, advanced knowledge of the anthropoid apes, or prepared the way for epochal progress by rendering the identification of subjects more certain. There are I. Klein (1751), Brisson (1756), Erxleben (1777), Blumenbach (1775, 1825), Pennant (1781), Vicq-d'Azyr (1792), E. Geoffroy-Saint-Hilaire and G. Cuvier (1795).

As a general tribute to the work of this group of enthusiastic seekers for bases of classification and nomenclature, we may say that the fundamental importance of taxonomy is attested by the entire history of anthropoid research. If we should attempt to present adequately the anthropoid materials and discussions published during the eighteenth century by taxonomists, our chapter would stretch to a volume.

The contributions to anthropoid lore, in no way distinguished, from 1700 to 1750 are exemplified by the works of Bosman

(1705), Schouten (1707), Leguat (1708), Beeckman (1718), Careri (1727), Du Halde (1736), Boreman (1739), Scotin

Fig. 7. "Singe" from Java, presumably intended to represent the orang-outan. From Leguat, 1708.

(1739), Smith (1744), and Barbot (1746). We shall utilize them to indicate the nature of interest and inquiry and the extent of progress in the first half of the century.

Bosman, a traveler, in describing the animals of Guinea mentions a fawn-colored creature, little shorter than a man, called in Flemish *smitten*.

Do as I do, Sir, and believe whatever you wish to; one fact to which I can attest is that these animals are horribly wicked and seem to have been created only to do evil. . . .

These monkeys have a rather ugly shape, as do the second species, which they would resemble in every respect were it not that scarcely a quarter of them are as large as the first species. The best thing that can be said of these monkeys is that they can learn nearly everything one wishes. (Bosman, 1705, p. 259.)

The orang-outan is described by Schouten, Leguat, and Beeckman without addition to existing information, but with unfailing repetition of the superstitions of the natives. Beeckman for several months kept a young orang-outan with him. The drawing (fig. 8) which we have borrowed from his book certainly does not convict any one of accurate observation and delineation.

There are numerous trivial and entertaining references to the apes. For example,

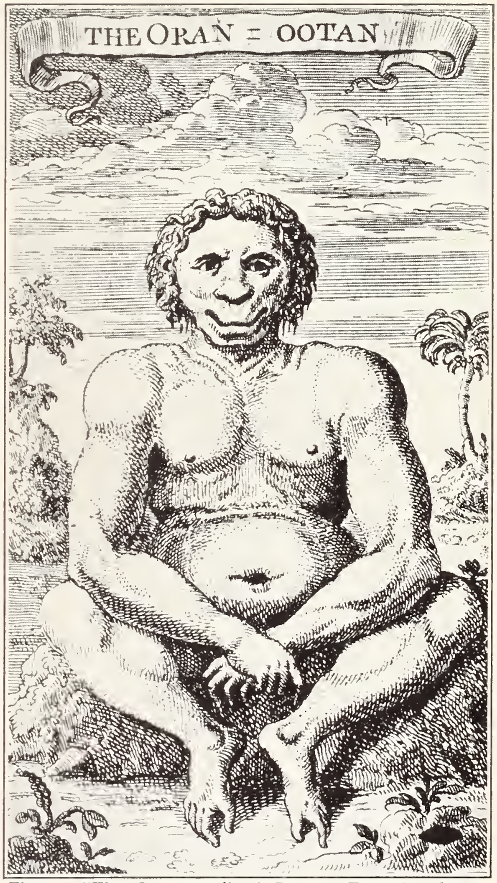


Fig. 8. "The Oran-ootan" of Borneo. From Beeckman, 1718.

that of the voyager Careri, who recounts the old story of how apes or monkeys safely effect the destruction of large oys-

ters by slipping stones between the open halves of the shell. (Careri, 1727, V, 155-156.)

In a compilation avowedly for the enter-

Fig. 9. "Female Pygmy or Chimpanzee." From Boreman, 1739.

tainment of the young, Boreman tells of the appearance and manner of life of the chimpanzee. His facts mostly are borrowed from Tyson. Referring to a female specimen which was brought from Angola to England in 1738, and which we with difficulty imagine to have been the subject of the drawing from Boreman's book (fig. 4, p. 22), reproduced herein as figure 9, that author writes:

The *Chimpanzee* was very pretty Company at the Tea-table, behav'd with Modesty and good Manners, and gave great Satisfaction to the Ladies who were pleased to honour her with their Visits, by several rational and seemingly diverting little Actions; it would fetch its little Chair, and sit in it naturally, like a Humane Creature, whilst it drank Tea: It would take the Dish in its Hand, and if the Liquor was two hot, wou'd pour the Tea into the Saucer to cool it, and so in various little Things, mimick Man to a surprising degree. (Boreman, 1739, p. 24.)

Scotin observed the chimpanzee of 1738, and, still more important, engraved it on brass. We had almost quoted "skilfully engraved" when a glance at the accompanying figure 10 (from Scotin, 1739, p. 564) inhibited us!

Accounts of the chimpanzee, brief and obviously based largely on the reports of natives, are given also by Smith (1744), who presents a curious engraving (p. 147) of a creature called the Mandrill; and by

Fig. 10. The London chimpanzee of 1738. From Scotin, 1739.

Barbot (1746), in whose writings we find nothing but the usual commonplaces and fancies.

The painter-naturalist Edwards (1758-64) stands as a somewhat notable figure in

the history of anthropoid knowledge because in addition to writing a readable popular description of the "man of the woods" he illustrated it with a figure entitled "The Satier, Sauage, Wild-man, Pigmy, Orang-outang, Chimp-anzee &c., A.D. 1757, Geo. Edwards, Delin.et Sculp.," in which he so skilfully mingled the structural characters of orang-outan, chimpanzee, and gibbon that one cannot more exactly name the figure than by the synonyms which the artist himself used. Whereas one portion of Edwards' description refers unquestionably to the orang-outan, another is applicable only to the chimpanzee. In his illustration, which we present as figure 11, the full-length drawing suggests the chimpanzee, whereas the profile resembles the orang-outan. It is but natural then that we should find it difficult to think of him as an anthropoid authority.

Fig. 11. Chimpanzee, orang-outan, or both? From Edwards, 1758-64.

In the *Anthropomorpha* of Hoppius (1760), who was a pupil of Linnaeus, one discovers a historical disquisition suggestive of the writings of Gesner and Aldrovandi. Although the work marks progress in acquaintance with anthropoid types, contains some new information, and is in certain respects more critical and constructive than many similar writings of the sixteenth and seventeenth centuries, it gives the reader a lively impression of the meagerness and inexactitude of knowledge at that period.

That Hoppius was acutely dissatisfied with the materials which he could command is thus indicated:

> Since therefore no one, without extraordinary delight and wonder, can look upon the living genus of Simiae, so utterly ridiculous and curious, those just mentioned, which are most like men, should be studied with open minds by experts in natural history. Wherefore one comes to wonder how it has happened that man, eager to learn, has left them hitherto in darkness, nor has wished with so little reasonableness to know the Troglodytes, who are nearest to himself. Many mortals spend their days in the study of their appetites and desires and anxiously cogitate thus alone: in what manner they may heap up for themselves food and treasures howsoever scraped together; nor is the case different with the greatest part of those who seek the Indies in ships: to whom alone it happens that they see the genus of the Troglodytes: these, gaping with open mouths at so much wealth, think it beneath their notice to scrutinize the nature of natural objects and to explore their economy. But what, I ask, may be more conveniently an object of delight, even to Monarchs themselves, than to contemplate the animals of their home close at hand, whom we can never admire enough. Would it not be easy for the King, to whose will certainly a whole race bends, to get possession of them? It would lead not a little to Philosophy, if one were to spend a day with any of them, exploring how far human wit exceeds theirs, what distance lies between Brutish and rational discrimination; so that, moreover, light would arise for students of natural science from a complete description of them. This concerns me, for I am doubtful by what characteristic marks the Troglodytes are distinguished from Man, according to the principles of natural history; so near are some among the genera of Men and Apes as to structure of body: face, ears, mouth, teeth, hands, breasts; food, imitation, gestures, especially in those species which walk erect and are properly called *Anthropomorpha,* so that marks sufficing for the genera are found with greatest difficulty. (Hoppius, *op. cit.,* 2d ed., 1789, pp. 75-76.)

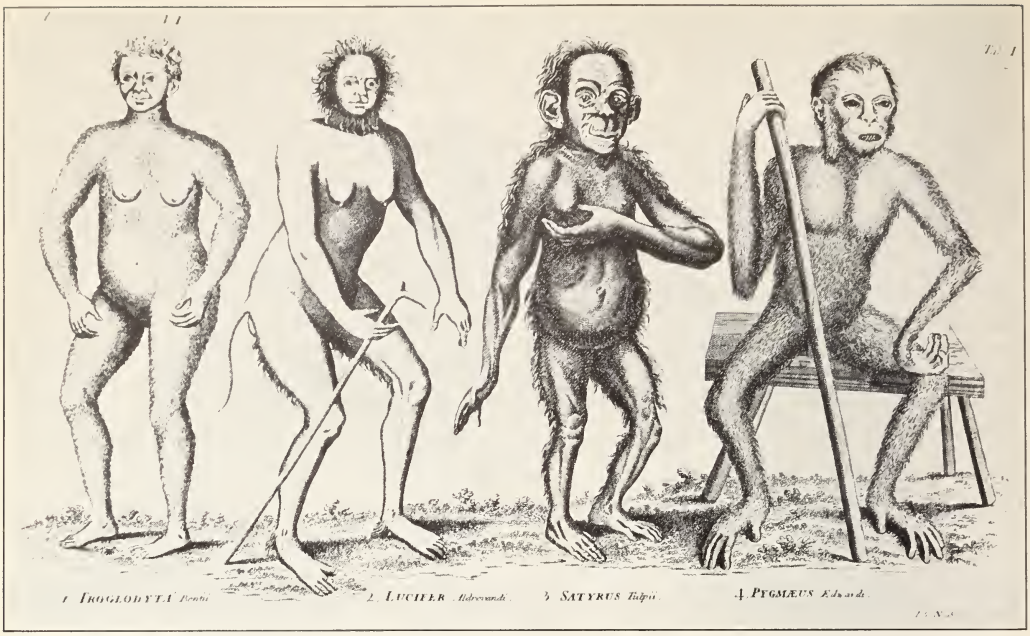


Fig. 12. Historically interesting figures borrowed from other authors by Hoppius, 1760.

Familiar with the lore of the ancients and the facts and superstitions of his own time, Hoppius described verbally and pictorially four types of Anthropomorpha: Pygmaeus (uncertainly identifiable as the orang-outan), Satyrus (the chimpanzee), Lucifer (wholly imaginary), and Troglodyta (also imaginary). Although like his textual matter, the illustrations of Hoppius are borrowed from other authors, and that not without alterations, we have reproduced as figure 12, for the entertainment and enlightenment of the reader, the drawings which appear on his page 76. Could one more impressively represent the status of knowledge of the anthropoid apes in the middle of the eighteenth century?

The famous *Natural History* of Buffon (1749-67, vol. 14, 1766), written almost simultaneously with the *Anthropomorpha* of Hoppius, contrasts arrestingly with the latter. Aside from being delightfully written, it is a reasonably authoritative source of information which, therefore, we shall have abundant cause to refer to and draw upon in our later chapters. If the reader wishes a single reference for the materials of this chapter, and the historical period which it represents, it must be the work of the gifted French naturalist.

Even those with training in a learned profession and in the natural sciences frequently have written mistakenly and, therefore, misleadingly of the great apes. Edward Bancroft, M.D., is an unfortunate example, for, relying too much on the truthfulness of the native Indians, he attributed to Guiana in South America an orang-outan "much larger than either the *African* or *Oriental,* if the accounts of the natives may be relied on." (Bancroft, 1769, p. 130.) We quote the last phrase in extenuation. Yet one marvels that so utterly false a statement, from the pen of a physician, could have got into print so recently.

While reading thus far in these historical chapters many must have noted the paucity of references to gibbons and the lack of descriptive information. This defect is now to be partially remedied, for in the last half of the eighteenth century several

eminently useful accounts of the gibbon were published. We have selected as examples those of de Visme (1769), Turpin (1771), and van Iperen and Schouman (1784).


Fig. 13. Male and female gibbons. From de Visme, 1769.

As occurring in the interior of Bengal, de Visme tells of the Golok, which we readily identify as a gibbon. His drawings, our figure 13, also represent a gibbon. We quote the following comment on de Visme's observations chiefly because of the point it gives to our remark about the value of Buffon's *Natural History*.

> The monkey, of which Mr. De Visme has sent this drawing and short account, seems to be very like, if not the same with the ape without a tail, described by Mr. De Buffon in the XIVth volume of the Histoire Naturelle, p. 92, under the name of the Gibbon, which it bears in some parts of the East-Indies. This species is found, he says, along the coast of Coromandel, at Mallacca, on the Molucca islands, and upon the confines of China. It grows to be upwards of four feet, walks on its hind legs, and sometimes on all four. The hair, with which it is covered, is either brown or black: round about its face is a circle of greyish hairs; its eyes are large, but sunk in its head; its ears naked; its face flat, and of a copper colour. It is of a placid disposition; its motions are gentle; it was fed with bread, fruits, almonds. But the most singular characteristic is, the great length of its arms; and though Mr. De Visme takes no notice of this circumstance in his description, his drawing seems to indicate it; but in a less striking manner than that of Mr. De Buffon, who adds, that, when the animal is upright, it can touch the ground with its hands. (De Visme, 1769, p. 73.)

Among the "monkeys" of Siam, Turpin mentions the *onke*. It is the white-handed gibbon of current natural history. The author's description of this animal's appearance and behavior, although brief, is useful.

In a quite different category, scientifically, than the contributions of de Visme and Turpin, is that of van Iperen and Schouman, who in 1784 published what appears to be the best early description of a species of gibbon. The native name for this creature, wau-wau (or wah-wah), these authors say is supposed by some to be taken from its resemblance to a little old woman, the meaning of the Javanese *wah.* They, however, believe that it is taken instead from the animal's cry.

Although many authors previously had supplied descriptions of the gibbon sufficient for general identification, it remained for van Iperen and Schouman to trace the history of the subject and to give a rea-

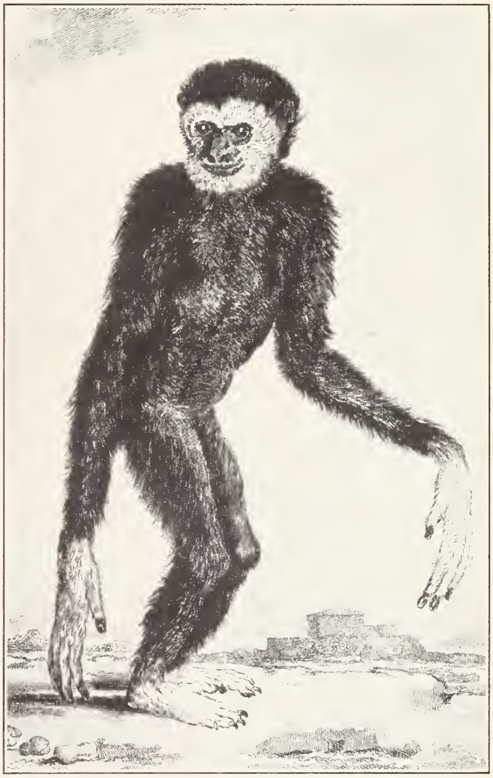


Fig. 14. "The Great Gibbon." From Buffon, 1766, vol. 14.

sonably complete account of the appearance, sounds, general behavior, points of difference from other species, and physical measurement of the wau-wau. They state

Fig. 15. The "Jocko" or chimpanzee. From Buffon, 1766, vol. 14.

that the Javanese distinguish, chiefly on the basis of coloration, three species of which the wau-wau is the gray and black. It was natural that in contrasting the wau-wau with other species of gibbon they should come to question the practicability of classing it with them. Finally they concluded that wau-wau and gibbon are different types of tailless ape. Considering the prevalent confusion of types and the abundance of contradictory statements, the contribution of van Iperen and Schouman must be regarded as of unusual scientific merit.

The unprecedented taxonomic activity and progress of this period, with its aggressive search for characters useful in identification and classification, stirred interest in similarities and relationships. Inevitably there arose queries, arguments, disputes about the relationship of anthropoid apes to man. Although many of the eminent systematists might fairly be mentioned in this connection, the outstanding figure, because of his warmth and energy, is Monboddo (1773, 1784). Writing much and lucidly, although not always with unimpeachable logic and fairness, he reviewed for his own purposes much of the available information about anthropoid apes. In marshaling facts relative to relationships he proved to his satisfaction the close structural and psychobiological similarity between man and great ape, and insistently argued that speech is not distinctively human.

Contrasted with Monboddo, the philosophically minded, is Long, the historian, who in 1774 while recounting the history of Jamaica, a land wholly devoid of anthropoids, became engaged with the perplexing problem of relations, and discussed it both intelligently and with fair command of information.

Although he also was keenly interested in relations, it would be grossly misleading to class Blumenbach with Monboddo and Long, since he approached the subject rather by giving impetus to anthropological observation than by speculative argument or historical description. One finds many excellent comparisons of structure and behavior and various well-founded arguments in Blumenbach's *On the Natural Variety of Mankind* (1775), along with generally reliable, but in the main secondhand, historical and descriptive anthropoid materials. The intellectual quality of this author and his bias concerning relationship are made clear by these few sentences:

It is indeed beyond all doubt that the fiercest nations, the Californians, the inhabitants of the Cape of Good Hope, &c, have a peculiar sort of speech, and plenty of definite words, and that animals on the contrary, whether they be like man in structure, as the famous orang-utan is, or approach man in intelligence, to use the words of Pliny about the elephant, are destitute of speech,

and can only emit a few and those equivocal sounds. That speech is the work of reason alone, appears from this, that other animals, although they have nearly the same organs of voice as man, are entirely destitute of it. (Blumenbach, 1775, quoted from 1865 ed., pp. 83-84.)

Another property of man comes directly from the foregoing, namely, his two hands, which I consider belong to mankind alone; whereas apes, on the contrary, must either have four or none at all, of which the great toe being separated from the other fingers of the feet serves the same purposes which the thumbs do in the hands. This is so certain, that on that account alone the fœtus said by Robinet to be that of a pongo, must certainly be considered a human embryo, even if no notice be taken of the other proportions of the bodily parts, and the whole structure which is entirely human. (P. 86.)

Although "relationship" during the eighteenth century attracted the attention of many, and monopolized that of a few, able individuals, it was not until the nineteenth century that it became a dominant intellectual issue. The chief factual contributions for which it may be held responsible in the eighteenth century are studies of the vocal mechanism, speech, or other forms of vocalization, and the characteristics of hand and foot in anthropoid apes as compared with man.

In the second edition of his remarkable essay on *The Origin and Progress of Language* (1774) Lord Monboddo inserted a letter from a former "captain of a ship trading with the slave coast of Africa" in which the gorilla is mentioned among three "classes or species" of African apes.

Of this animal there are three classes or species; the first and largest is, by the natives of Loango, Malemba, Cabenda, and Congo, called or named Impungu. This wonderful and frightful production of nature walks upright like man; is from 7 to 9 feet high, when at maturity, thick in proportion, and amazingly strong; covered with longish hair, jet black over the body, but longer on the head; the face more like the human than the Chimpenza, but the complexion black; and has no tail. (Monboddo, 1774, I, 281.)

The Impungu of this letter, in our opinion, is the gorilla, for in addition to describing the giant ape consistently, the author contrasts it with the chimpanzee. Apparently Monboddo has supplied the only unmistakable and scientifically useful reference to the gorilla in the literature of the eighteenth century.

To Vosmaer, Camper, and Wurmb we owe the signally important original contri-

Fig. 16. Orang-outans. From colored plate of Vosmaer, 1778.

butions of the century. While others for the most part were content to recount the stories of natives, with a few original observations thrown in, or to re-present materials already many times printed, these three, Dutchmen all, relied on original inquiry, and as anatomists made themselves intimately acquainted with the appearance, structure, and many aspects of the behavior of the orang-outan.

Vosmaer's historical introduction to his description of a very rare and odd species of monkey (1778) indicates his inability to distinguish the African chimpanzee from the Asiatic orang-outan. This, however, is not to be wondered at. While doubting even the existence of the rumored "great orang-outan," for twenty years he diligently sought reliable information about it, or a living specimen. In 1776, he succeeded in obtaining one from Borneo. His

account of the appearance, daily life, and behavior of this specimen is of finer scientific quality than much of the more recent behavioral work with anthropoid apes. Because the publication of Vosmaer is of wholly exceptional importance, and pre-eminently worthy of use in our later special discussion of the behavior of the orang-outan, more lengthy exposition or comment in this historical chapter is inappropriate.

The orang-outan is the subject also of a valuable contribution by Camper. From his excellent historical introduction one discovers that he had read critically the principal works of his predecessors, and unlike most of them had dissected the orang-outan as well as several other primates. Of identification he pertinently and plainly remarks:

It is useless to repeat here what has already been written of this species by Buffon (vol. 14, p. 48), inasmuch as this great and indefatigable naturalist, never having seen a real Orang,—one from Borneo—, was induced by an error of Tulpius and Tyson, to place this great tailless, African ape in the kingdom of Angola and in Guinea, among the true Orangs, from which they differ considerably, as we shall show.

That which has been said of the African apes, that which has been recounted by voyagers of Pongos, Jockos, etc., cannot, under any condition, be applied to the animal in question; I shall not adopt much of what has been alleged in this respect by the general nomenclators, by Linnaeus, for example, and by his pupil Hoppius, of the simple conjectures, the miserable reports and false descriptions. I say the same of Brisson and, in short, of all the authors. These writers never saw the Orang of Borneo, when they undertook to give them names, and they were, in spite of themselves, mistaken, because they never gave a clear and exact description of this rare and unique animal. Edwards is the only one who can be considered to have written something with certainty; but, as he was neither an anatomist nor a naturalist, and only a very mediocre painter, he gave us only a very poor description and a still worse illustration. He observed correctly, however, that Tyson's illustration of the Orang was by no means satisfactory; but that a certain Captain Beeckman described, in the voyage to Borneo, made in 1718, an Orang, which, though similar to his own, was not quite the same; for, in truth, it could not be the same creature, if it is true that this animal was covered with hair in the places thought to be characteristic of human beings, since it is on the back and on the outside of the legs and arms that the Orang is the most hairy, as Aristotle has already observed. (Camper, 1779, from 1803 ed., I, 44-46.)

We have quoted thus at length to indicate at once the persistent confusion of types and our author's critical acumen. Finally, as basis for his great contribution to our knowledge of the anthropoids Camper possessed a fund of information gathered from the study of living specimens, measurement of cadavers, and complete dissections. Although his descriptions of behavior are useful, his morphological contribution is of surpassing value because he was primarily an anatomist.

In concluding the anatomical section of his book Camper writes:

I believe I can conclude, after enumerating all the external and internal specific characters in such great number in the Orang, which I have described and illustrated with the most scrupulous exactitude, that:

First, the Orang differs greatly from Man as much in shape as in height, and in behavior; that he is unable to speak or to sit down like man, or to lie on his back, and still less to grasp anything, because his thumb is much too short.

Secondly, that the Orang is actually a quadruped, with great similarity to certain monkeys (singes), such, for example, as the Gibbon, and the Pygmy of Tyson, but that, on the other hand, he differs from them greatly in vocal organs, and in the skeletal arrangement of the hands and other parts of the body; that he is furthest removed from the Pithecus, above all in vocal organs, shape of the body, intestines, and in skeleton, particularly that of the hands.

The Orang-Outang of Borneo is consequently an animal which should be placed in the general class of monkeys (singes) *or four-handed animals* (quadrumanes); *but which however forms a totally disinct species.* (*Op. cit.*, pp. 145-146.)

In a briefer communication transmitted to the Royal Society of London, and published in the same year with his epoch-making book on the orang-outan, Camper discusses the structure and functions of the "organs of speech" of the orang-outan. His conclusion, however well it may then have seemed to be founded, sounds to the present-day reader dogmatic and overinclusive.

Having dissected the whole organ of voice in the Orang, in apes, and several monkies, I have a

right to conclude, that Orangs and apes are not made to modulate the voice like men: for the air passing by the *rima glottidis* is immediately lost in the ventricles or ventricle of the neck, as in apes and monkies, and must consequently return from thence without any force and melody within the throat and mouth of these creatures: and this seems to me the most evident proof of the incapacity of Orangs, apes, and monkies, to utter any modulated voice, as indeed they never have been observed to do. (Camper, 1779a, p. 155.)

Grave misgivings about the correctness of some of Camper's conclusions do not lessen our admiration for his contribution of fact. Together he and Vosmaer, by conspicuously impressive example, established a new and highly profitable fashion in anthropoid research.

The interesting story of the capture of the "great orang-outan" (adult) finally studied by Vosmaer, is told by Radermacher, who after listing the known specimens, presumptively of orang-outans, and inviting attention to their small size, approximately two and one-half feet in height, continues:

The large species, described by Buffon and other authors as of the size of a man, is held by many to be a chimera. And perhaps this would have long been a riddle, if Palm, merchant and resident of Rembang, in his journey from Landak to Pontiana, had not shot one and sent it, in liquor, to Batavia, which same by the Batavia Co. was immediately sent to Netherlands to Heer A. Vosmaer for the collection of His Illustrious Highness. Heer Palm wrote me as follows: "Herewith you receive, against all expectation, (altho I had previously offered more than one hundred ducats to the Borneans and Banjarees for an orang outan of four to five feet) one which I killed about eight o'clock in the morning in this region. Long have we been busy, with every means thought of, and in the deepest wilderness, about half way to Landak, to capture this terrible creature alive. Moreover we have this day been more beset to hold him, at once taking care that we should not be hit by him; the while he incessantly broke green branches in pieces and threw them at us. This game lasted until four o'clock in the afternoon; then we decided to give him the bullet: maybe in this I succeeded too well, a better than I has not always shot at such a mark; the bullet went just in the side in the upper part of the body, and thus is the animal little harmed. We brought him yet living in the piroque, bound him to the posts of the roof of the quay which served us as a tent; where in the morning when we went to get him, he was found dead." (Radermacher, 1780?, quoted from 3d ed., 1826, pp. 65-66.)

Evidently before this orang-outan was sent to Holland it was examined by Wurmb (1781) whose careful account of its external appearance, including a long list of physical measurements, together with a historical discussion, was published in the same volume as the article by Radermacher just quoted. That Wurmb's description of the "great orang-outan" was deemed of peculiar scientific importance is evidenced by the fact that Jansen (1796) translated it from Dutch into French, and in 1798 it was translated into English for publication in the *Philosophical Magazine*. In the same year it was adversely criticized by Geoffroy-Saint-Hilaire, who believed that instead of "the large orang-outan or Pongo" Wurmb had discovered a new species of ape.

I shall not pursue any farther an explanation of the characterising marks which it exhibits to naturalists. I have said enough to prove that it is not the orang outang or pongo, but that it ought to be considered as a species unknown before the publication of Wurmb's memoir. I am far from reproaching that observer for his mistake. At the time when he wrote his description the natural history of the orang outangs was involved in such obscurity, that he must naturally have considered his ape to be the same animal as the large orang outang or pongo of Buffon. Naturalists were then far from being convinced that this animal, such as it is described in the immortal work of that celebrated author, is an imaginary being to which Buffon has assigned a form and characterising marks, by confounding, under the same name, and in the same description, six different species of apes described by travellers. (E. Geoffroy-Saint-Hilaire, 1798a, pp. 341-342.)

Although we have mentioned only the more important and, for one reason or another, typical publications of the period, we have all but finished our survey of progress in anthropoid research during the eighteenth century. Despite growing interest and increased enthusiasm for the collection and study of specimens, the three principal known types of anthropoid ape were generally confused even at the end of the century. The gorilla, as a scientific object, was practically unknown; the gibbon

was uncertainly known because of contradictory descriptions attributable to different species, and the chimpanzee and orang-outan continued to be confused, partly because of the long standing assumption of two varieties, the black in Africa and the red in Asia.

It will profit us historically to take our end-of-the-century orientation from the systematists. Turton's translation of Gmelin's edition of the *Systema Naturae* of Linnaeus mentions under the Simia six sorts of tailless ape: (1) Troglodytes, the black-coated ape from Angola (probably a chimpanzee, barely possibly the gorilla). (2) Satyrus, of which there are three species; (a) the red-coated ape of Borneo (then and now called orang-outang); (b) a second species or type of Satyrus called Pongo, found in Java and Guinea and of much greater size than the Bornean orang-outang (this also may refer to the adult orang-outang, chimpanzee, or gorilla); (c) a third species of Satyrus smaller than either of the others (possibly the immature Pongo). (3) Lar, long-armed apes (which we recognize as gibbons), found in India. Three species are mentioned which are distinguished by differences in color markings and size. (4) Sylvanus, the Pigmy of Africa and Ceylon (possibly this also refers to the chimpanzee). (5) Inuus, the African Magot (our Barbary ape). (6) Suilla, the hog-faced ape (undoubtedly a species of monkey). (Linné, 1806, I, 10-11.)

That it is not easy to identify the various types of ape mentioned by Gmelin is obvious. Kerr, in his translation of Gmelin's Linnaeus, lists as Simiae: (1) Chimpanzee, *S. troglodytes,* great ape; (2) Orang-outang, *S. satyrus, Homo sylvestrius;* (3) Pongo, *S. satyrus pongo,* also called *Homo sylvestrius* and orang-outang; (4) Jocko, *S. satyrus jocko;* (5) the Great Gibbon, *S. longimana,* the long-armed ape. (White, 1799, pp. 29-31.)

Pennant, adversely critical of the system of Linnaeus, proposed in his *History of Quadrupeds* (1781) seven divisions of the tailless ape: Great apes, Pigmy apes, Long-armed apes (Lesser and Malacca), Golok, Lar, Barbary, and Hog-faced. One readily discovers in this list the adult manlike apes as "great apes," their young as "pigmy apes," and three species of gibbon as "long-armed apes," "Golok," and "Lar." Neither the Barbary nor the hog-faced ape belongs to the group of anthropoids as at present defined. (See 3d ed., 1793, of Pennant.)

Fig. 17. "Long-armed Ape," doubtless a gibbon. From Pennant, 1793.

It seems almost incredible, yet it is evidently true, that with all their descriptive and taxonomic efforts the scientists of the eighteenth century made small progress toward the satisfactory and certain identification and classification of the four types of anthropoid ape then, as now, existent.

CHAPTER FOUR

THE EMERGENCE OF THE GORILLA

OUR task of tracing the growth of scientific knowledge of the anthropoid apes to the time when all of the types were definitely recognized and distinguishable remains incomplete. At the end of the eighteenth century confusion still reigned and the gorilla was virtually unknown. In this chapter we shall depart farther than heretofore from the simple chronological arrangement of our materials in order to indicate with brevity informational trends and advances with respect to topics and types. Our principal theme will necessarily be the scientific discovery of the gorilla. The period covered extends approximately to 1865. Thereafter scientific study of the anthropoid apes rapidly became systematic, specialized, and intensive.

Fig. 18. The chimpanzee, misnamed "Pongo" by the author. From Audebert, 1800.

Contributions marking the transition from the spirit of the eighteenth century to that of the nineteenth, and also typical of the early years of the new century, are those of Audebert (1800) and Shaw (1800), the former essentially an artist, the latter a zoölogist. Following in the footsteps of Buffon, Audebert undertook to describe the known primates and to picture them accurately from life. Shaw, by con-

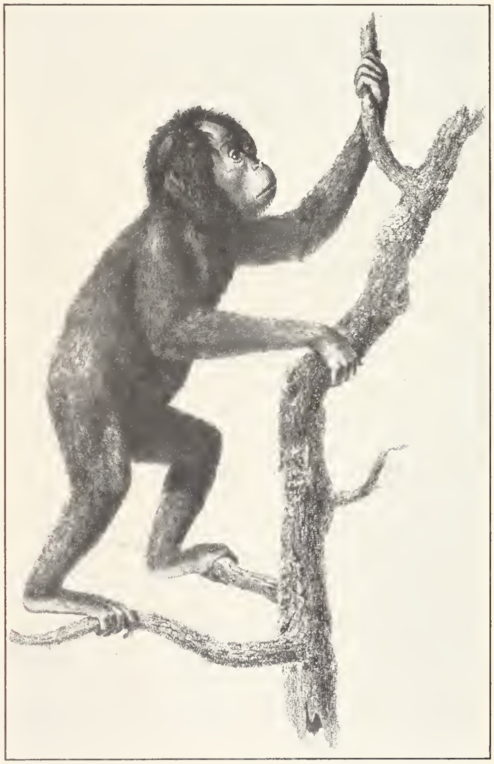


Fig. 19. The orang-outan (immature), by the author misnamed "Jocko." From Audebert, 1800. This is from an excellent colored plate.

trast, was a masterly assembler of information who in his fourteen-volume general zoölogy presented the anthropoid informa-

Fig. 20. The gibbon "*Simia lar.*" From Audebert, 1800.

tion of his time. Because of the admirable quality of their expositional labors, these two writers, though otherwise sharply contrasted, belong together. They are equally worthy of consultation and reference. From them we may appropriately take our topical departure, since original, as contrasted with compilational, publications became increasingly numerous and important as the century advanced. Neither Audebert nor Shaw was entirely clear as to anthropoid types, relations, and characters, and neither recognized the existence of the gorilla.

Previously we have remarked that classificatory or taxonomic interest and effort follow upon, and perhaps spring from, crude and undifferentiated naturalistic activity. Similarly in the anthropoid research of the nineteenth century we observe morphological interest arising from and rapidly supplementing the taxonomic. Quickly it gained headway and became a new zoölogical fashion, so that the century presently came to seem preëminently the era of morphology. In these reflections we are not overlooking the growth and directive influence of the Dutch school of anatomy in the previous century.

Although this volume is devoted to anthropoid behavior we cannot fairly omit mention of the nature and influence of taxonomic and anatomical contributions. In the nineteenth century G. Cuvier, Blumenbach, Illiger, the Geoffroy-Saint-Hilaires, de Blainville, and Owen are conspicuous for their contributions to zoölogical science, and each assisted notably in the advancement of knowledge of the anthropoid apes. They introduced ideas, methods, hypotheses, and through admirable constructive effort and the marshaling of facts radically altered the status of their science.

Although many other able biologists during the early years of the century aided in developing and perfecting the classification and morphological description of the anthropoid apes, de Blainville and Owen

Fig. 21. The "Moloch," perhaps the gray gibbon or wau-wau, *Hylobates leuciscus*. From Audebert, 1800.

for many reasons deserve special mention. The one contributed abundantly to history, taxonomy, and anatomy; the other,

with remarkable accuracy, energy, and clarity, to anatomical description.

Excellent general and naturalistic accounts of the anthropoid apes appear to be distinctive of the period. Better than any other sources they indicate the growth of knowledge and the trends of interest. The reader who would quickly and with minimum effort make himself master of what was known about the apes in the second quarter of the century cannot do better than read carefully the *Natural History of Monkeys, Opossums, and Lemurs* (1838),[1] and Martin's *General Introduction to the Natural History of Mammiferous Animals* (1841). These books should be in the library of every student of primate behavior. Unfortunately they are rare and relatively little known. The general description of anthropoid life by Boitard (1842), although of the same period, is less satisfactory than the works of Rennie and Martin, whereas the more recent and more widely known natural history of Brehm (1864-69) is preëminently useful.

Anyone who reads in order Gesner (1551), Buffon (1766), Rennie (1838), Martin (1841), and Brehm (4th ed., 1922) on the anthropoid apes will experience a series of impressions covering the characteristics of human interest, the nature and methods of inquiry, and the scope and reliability of information during successive periods. We strongly recommend this intellectual recreation to any reader who may wish to supplement our brief historical outline.

In the nineteenth century confusion of orang-outan and gibbon does not appear, but separation of chimpanzee and orang-outan was less definite and certain. This defect in systematic knowledge and practice rapidly corrected itself, and in most of the reputable scientific contributions of the century the African anthropoids are recognized as distinct from the Asiatic. It was in 1821 that Traill described the anatomy of the chimpanzee under the name of "orang-outang." The confusion, however, existed in name alone, for this author distinguished from his African specimen the Indian brown orang-outan.

The narrative of a journey through China by Abel (1818) contains a serviceable account of the history of acquaintance with the Bornean orang-outan, together with description of certain aspects of behavior. This author also deemed it necessary to direct attention to the confusion of the Bornean orang-outan with the African ape, which he states to be the "Pongo."

Later Abel (1825) published an account of the capture of a huge male orang-outan. With recourse to physical measurements and drawings he described the "remains." Especially emphasized in this contribution are the size ("a full head taller than any man on board") and the extraordinary tenacity of life of this creature when mortally wounded.

Further clarifying accounts of the structure, mode of life, and behavior of the orang-outan are found in Jeffries (1825), Grant (1828), Tiedemann (1827), who compared the brain of the orang-outan with that of man, Temminck (1835-41), who acceptably monographed the primates, and Schlegel and Müller (1839-44).

James Brooke, in a letter read before the London Zoölogical Society in 1841, announces the shipment to London of five live orang-outans and states that he can prove the existence of two, if not three, distinct species in Borneo. His communication contributes also to the natural history and morphology of the ape.

Pursuing his interest in species and geographical distribution, Fitzinger (1853) reviews the history of the orang-outan in scientific literature and concludes from the records and his own observations that there probably exist two species in Borneo and two in Sumatra.

These typical and important contributions, selected from many which would be mentioned in an exhaustive study, fairly represent trends of interest, inquiry, and

[1] This anonymous work, published in a series called "The Menageries," is attributed to James Rennie and by us listed under his name.

progress. They have been selected to mark decisively the achievement of such knowledge of the orang-outan that confusion was

Fig. 22. Drawing of a gibbon. From Harlan, 1825.

rendered impossible and the differentiation and identification of species facilitated.

With the gibbon the case is different, because of the multiplicity of species and the consequent greater difficulty in obtaining adequate taxonomic data. Though this ape was known to the ancients even earlier perhaps than the orang-outan, and to science at least as early, progress toward adequate knowledge of it has been slower. Prior to the nineteenth century three or four apes, identifiable by us as gibbons, had been described, and in the early years of the century this number was increased to half a dozen. During the first half of the nineteenth century general acquaintance with the genus and its several species was furthered more or less notably by Raffles (1822), E. Geoffroy-Saint-Hilaire and F. Cuvier (1824), and Horsfield (1824). An exceptionally interesting description of a male specimen of *Hylobates syndactyla* is given by Bennett (1834).

However, even as late as 1834 Lewis could write as follows:

> These animals have been placed, by recent systematic naturalists, as a sub-genus of the Ourangs, with which they were confounded by the earlier writers. But their organization demonstrates much more recession from the great standard, man, than the latter, more especially in the elongation of the anterior extremities, and their dental peculiarities. Illiger, a Prussian anatomist, has designated them under the term HYLOBATES, to express their habits as inhabitants of the forests, and some remarkable additions have been made to the genus, so that five species have been described by Lesson in his supplement to Buffon, viz., H. Syndáctylus, *the Siamang;* H. Lar, *the Great or Black Gibbon;* H. Leuciscus, *Moloch or Cinereous Gibbon;* H. Variegatus, *Little Gibbon or Wouwou;* H. Unko, *the Ounko.* To which number Dr. Harlan, of Philadelphia, added another which he termed *Concolor.* (Lewis, 1834, p. 32.)

This taxonomic misadventure is surprising in view of the materials available. For although the literature on the gibbon was scanty and unsatisfactory, even by comparison with that on the orang-outan, it offered no obvious excuse for placement of the two animals in the same genus.

General systemic, naturalistic, and anatomic works provide ample evidence that by the middle of the century (see Elliot, 1913, III, 150 ff.) the structure and natural history of the gibbon were known as intimately, if not as fully and accurately, as those of the orang-outan and chimpanzee. The statement does not apply to behavior, because the relative delicacy of the animals had prevented their successful transfer to Europe and limited opportunities for observation of living specimens.

As a matter of fact confusion of orang-outan and chimpanzee very nearly ended

with the previous century and it is somewhat misleading, and unfair to zoölogical authorities of the period, to exhibit instances of its persistence. Nevertheless they occurred.

By 1850 significant inquiries already mentioned, including those of leading systematists and anatomists, had established separate genera for chimpanzee, orang-outan, and gibbon. Explanation of the long persistent confusion of chimpanzee and orang-outan, and insistence on their association in a single genus, is found in the remarkable differences between the young and the adult stages of these manlike apes and the extreme difficulty of scientific observers in getting trustworthy information about either stage of development or source of specimens.

Definite knowledge of the gorilla is peculiar in several respects but chiefly in its recency. As object of scientific study this ape simply did not exist at the beginning of the nineteenth century, and it was not until the middle of the century that it was definitely described and generally accepted as a new genus of anthropoid ape.

As an introduction to the following chronological account of the history of scientific acquaintance with the gorilla we shall briefly review what may be considered prescientific references to the animal. We consider those which we shall present samples, for we lack even the desire to present a complete list of the works of explorers, travelers, adventurers, hunters, and others in which more or less definite and unmistakable reference to the giant ape appears.

Hanno's description of the gorilla in the fifth century, B.C., we have already (p. 3) cited as in our opinion inapplicable. The next mention of a large unidentified ape is that of Battell (Purchas, 1625), whose "Pongo" surely was the gorilla, while the native term *engeco* used by him (p. 10) designates the chimpanzee. The third plausible reference has been overlooked or for other reasons neglected by most historians. It is to be found in the second edition of Monboddo's work on language (1774) as already quoted (p. 23). The evidence convinces us that the gorilla was the object of remark by Monboddo's informant and that he had reasonably reliable although scanty information. It is difficult to understand why this letter, when published in so important a book as that of Lord Monboddo, should not have stirred naturalists and adventurers to determined search for the giant ape.

Some forty years later Bowdich (1819) in his *Mission from Cape Coast Castle to Ashantee* wrote thus of the African anthropoid apes:

> The African Ourang-outan (Pithecus Troglodites) is found here, the one I saw was two feet and a half high, but said to be growing. I offered a fair price for it, considering they are not rare there, and would not give more when I heard of one being already in England. The native name is Inchego: it had the cry, visage, and action of a very old man, and was obedient to the voice of its master; its agony on espying the panther on board was inconceivable. There is a curious variety of monkeys. The favourite and most extraordinary subject of our conversations on natural history, (which I introduce merely to excite enquiry) was the Ingēna, compared with an Ourang-outan, but much exceeding it in size, being generally five feet high, and four across the shoulders; its paw was said to be even more disproportionate than its breadth, and one blow of it to be fatal; it is seen commonly by those who travel to Kaylee, lurking in the bush to destroy passengers, and feeding principally on the wild honey, which abounds. Their death is frequently accelerated by the silliness which characterizes most of their actions: observing men carry heavy burthens through the forest, they tear off the largest branches from the trees, and accumulating a weight (sometimes of elephants teeth,) disproportionate even to their superior strength, emulously hurry with it from one part of the woods to another, with little or no cessation, until the fatigue, and the want of rest and nourishment, exhausts them. (Bowdich, 1819, pp. 440-441.)

In the light of what we now know of the native names for chimpanzee (*engeco*) and gorilla (*engena*), it is wholly reasonable to infer that the extraordinary subject of conversation was the gorilla. Yet even this unmistakable reference, perhaps because it appeared in a general account of the kingdom of Ashantee instead of in a biological

publication, failed to discover the giant ape to scientists.

Another quarter century and the gorilla actually emerged! Its discovery is owing primarily to the naturalistic interest of Protestant missionaries and their personal contacts with eminent anatomists. Wilson and Savage are the missionaries to whom chief credit belongs, Wyman and Owen their scientific collaborators. Jointly, in 1843-44, Savage and Wyman had published observations on the external characters and habits of the chimpanzee *Troglodytes niger,* Geoff. and in 1847 their cooperation led to brief description of the appearance, habits, and cranial structure of the Engé-ena, which obviously is one spelling of a local name for the gorilla. Savage in the same year had sent to the English anatomist Owen some drawings of the skull of a form of ape which he proposed to call *Troglodytes gorilla* in distinction from *Troglodytes niger,* the chimpanzee.

The publication of Savage and Wyman stands as the first scientific account of the gorilla. As such it is worthy of quotation. The opening paragraphs are of peculiar interest as showing inadequate knowledge of the taxonomic literature of the period.

> Four species of anthropoid Simiæ, commonly known as Orangs, have been described by naturalists; of these, three are found in the eastern world, either on the continent of Asia, or the islands of Borneo, Sumatra and Java, and a fourth on the western coast of Africa. In the East there exists
>
> I. *Simia satyrus,* Lin. Pithecus satyrus, Geoff.; S. Abellii, Fisch.; L'Ourang outang, Cuvier; Red ourang. This is the species most frequently exhibited in an immature condition, in America and Europe, and is obtained in Cochin China, Malabar, and Borneo.
>
> II. *S. Wurmbii,* Fisch. Pongo Wurmbii, Kuhl. Grand Ourang-outang, Geoff. Dusky orang; from Borneo.
>
> III. *S. Morio,* Owen. Of this species the cranium has been described by Prof. Owen, but its external characters are not yet well known to naturalists.
>
> In Africa is found
>
> IV. *Troglodytes niger,* Geoff. Chimpanzée, Black Orang, Engé-eco, Jocko. This doubtless is the *Barris* of Pyrard de Laval, the *Smitten* of Bosman, *Quimpésé* of De la Brosse, and the *Quojas moras* of Tulpius.
>
> The existence of a second species in Africa, does not appear to have been recognized by naturalists, nor in fact has there been hitherto adduced any evidence on which its existence might be predicated, except the vague statements of the different voyagers and travellers. But these, resting principally on information derived from the natives, and not on the personal observation of the narrator, are in general so mingled with absurd and marvellous accounts, that they have been deservedly regarded as unworthy of credence. (Savage and Wyman, 1847, pp. 417-418.)

Continuing, the authors express their opinion that the Pongo of Battell is probably identical with their Engé-ena and state that:

> The *"Ingena,"* referred to by Bowdich, in his mission to Ashantee, is probably the Engé-ena of the natives of the Gaboon, though his statement, that the animal was "five feet high and four across the shoulders," detracts from the credibility of his narrative. Whatever doubt may have heretofore existed, the following notices of the habits, and external characters, and descriptions of the crania and some of the bones, will serve most satisfactorily to confirm the statements of Battell and Bowdich, with regard to the existence of a second African Orang, and to demonstrate that it is as specifically distinct from the *Troglodytes niger,* as from the Orangs of Borneo and Sumatra. The specific name, *gorilla,* has been adopted, a term used by Hanno, in describing the "wild men" found on the coast of Africa, probably one of the species of the Orang. (Pp. 419-420.)
>
> The killing of an *Engé-ena* is considered an act of great skill and courage, and brings to the victor signal honor. A slave to an Mpongwe man, from an interior tribe, killed the male and female whose bones are the origin of this article. On one occasion he had succeeded in killing an elephant, and returning home met a male Engé-ena, and being a good marksman he soon brought him to the ground. He had not proceeded far before the female was observed, which he also killed. This act, unheard of before, was considered almost superhuman. The man's freedom was immediately granted to him, and his name proclaimed abroad as the prince of hunters.
>
> It is said that this animal exhibits a degree of intelligence inferior to that of the Chimpanzée; this might be expected from its wider departure from the organization of the human subject. I could not ascertain that more than one or two at most of the young had ever been captured. One was taken and kept for a year by a native, and then sold to a Frenchman, but it died on the

passage home. Whether the skeleton was preserved is not known. No information respecting its habits in a state of domestication could be had upon which reliance might be placed. (P. 425.)

The authors conclude:

From the preceding descriptions there can be no reason to doubt that the Engé-ena is specifically distinct from the Enché-eco or Chimpanzée, the only member of the sub-genus Troglodytes hitherto recognized by naturalists. From the Enché-eco it is readily distinguished. (P. 436.)

This historical landmark in anthropoid literature includes a table of comparative physical measurements for orang-outan, chimpanzee, gorilla, and man.

Meanwhile, the distinguished anatomists Jeffries Wyman, of Boston, and Richard Owen, of London, were simultaneously engaged in examining evidences for the existence of a type of anthropoid ape new to science. But whereas the former, thanks to assistance of the missionaries, Wilson and Savage, had crania and other skeletal parts for study, Owen initially based his conclusions on drawings of the skull. At first he

Fig. 23. Drawing of a young gorilla. From I. Geoffroy-Saint-Hilaire, 1851.

declined, with justifiable conservatism, to believe a new species had been discovered. Subsequently and after careful study of osteological materials, he decided that they so far differed from *Troglodytes niger* as to justify the establishment of a species,

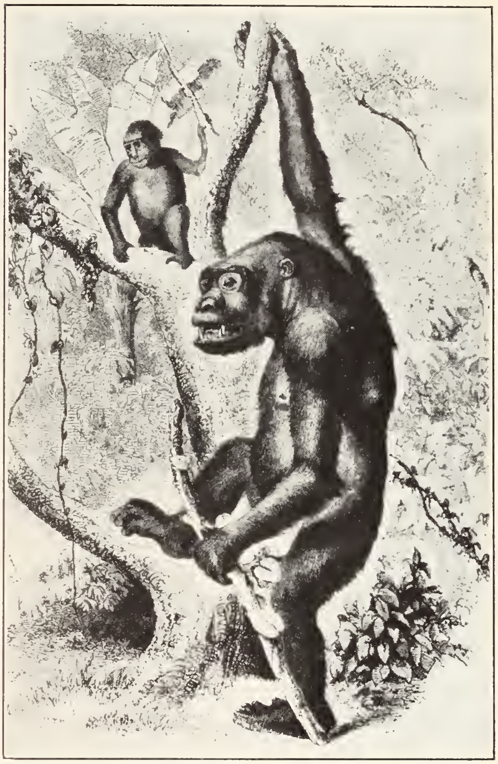


Fig. 24. Adult gorilla and young. From Gervais, 1854.

which in honor of its discoverer, Savage, he proposed to call *Troglodytes savagei* (Owen, 1859).

In the course of the next few years Owen published several important studies of the gorilla which, although primarily morphological, contain certain valuable observations on behavior and natural history (1859a, 1861, 1866). An important memoir appeared in 1865.

In 1851 Isidore Geoffroy-Saint-Hilaire announced to his scientific colleagues receipt by the Museum of Natural History in Paris of two preserved specimens of ape called in the Gaboon *Gina* or *Engina* and belonging to the species, so remarkable and still so little known by naturalists, designated as gorilla. This note was published in 1852 and in it the author tells us that

since 1828 his father, Etienne Geoffroy-Saint-Hilaire, had suspected the existence of a second type of African ape.

Further account of the characteristics of *Troglodytes gorilla* was supplied by Henry Ford (1852-53), whose brief descriptive communication to the Academy of Natural Sciences of Philadelphia is said to have been accompanied by a fine skeleton of the ape.

The first general treatise known to us in which the gorilla is described along with the other anthropoid apes is that of Gervais (1854). Under the names "Troglodytes, Gorille, Orang, and Gibbon" this author acceptably describes the structure, habits of life, and distribution of the four anthropoid types. Both illustrations and text are valuable, but the work is of unusual interest because it presents what appear to be among the earliest definitely recognizable drawings of the gorilla.

It was left to Isidore Geoffroy-Saint-Hilaire to assemble and present in conveniently readable form the widely scattered facts concerning the history and characteristics of the gorilla. This he did in a conspicuously important monograph (1858-61). It is his distinction and merit also to have established the genus gorilla.

It seems that the announcement by Savage and Wyman (1847) of a new African ape deeply stirred scientific interest. As a result both the English and the French instituted search for specimens. In the course of a few years numerous skulls, a few complete skeletons, and several cadavers were obtained. A skeleton received in Paris in 1849 and the specimens which arrived in 1851 commanded the immediate attention of the comparative anatomist de Blainville, whose work, interrupted by his death but continued by Duvernoy, was finally published by the latter in 1855-56. It is said that the two preserved specimens were exhibited at the International Exposition in Paris in 1852. According to Geoffroy-Saint-Hilaire, additional gorilla and chimpanzee materials arrived in Paris in 1853, 1854, and 1855, and as it is known that materials were received also in England, it is evident that the determined efforts to obtain specimens were reasonably successful.

Although he at first accepted Owen's designation of the gorilla as *Troglodytes savagei*, Geoffroy-Saint-Hilaire later maintained that the animal constitutes a distinct genus and that the specific name might better be *gina* than *savagei*. He, therefore, called it *Gorilla gina*. In addition to its historical materials, the Saint-Hilaire monograph contains excellent accounts of habitat, habits, and general behavior.

Following the discovery of the giant ape to science, and its establishment as a new genus of anthropoid, came its exploitation before the credulous public. For this the lay traveler and explorer Paul Du Chaillu was chiefly responsible. The publication of his *Explorations and Adventures in Equatorial Africa* (1861) marks the dramatic climax of his efforts. Lacking knowledge of biology and adequate scientific training for the task he set himself, his statements and even his specimens from the first aroused the suspicion of scientific authorities. Du Chaillu's honesty has been questioned, but whether or not fairly it is certain that he was grossly careless in exposition, and perhaps also in the handling of his gorilla exhibits. At any rate his publications were so far repudiated by the scientific world that even today they are considered first-rate examples of "nature faking." Although the critics of Du Chaillu and his work are numerous and they have published several attacks and commentaries, a single example, Gray (1861c), will serve to indicate their point of view and mode of destructive attack. Gray, among other things, accuses Du Chaillu of tampering with his zoölogical specimens and of using both the statements and the drawings of others without proper acknowledgment. However charitable his inclination, one must admit that the showing for Du Chaillu is bad.

With bare mention of the contributions to gorilla lore of Sanford (1862) and Reade (1863, 1864, 1868) we would conclude this historical sketch. It would be

rash to assert that all of the existent species and varieties of anthropoid ape are known to science even today. As late as 1903 Matschie described a new species of gorilla, *G. beringei,* just discovered by the German colonial officer Captain von Beringe.

The later years of the nineteenth century witnessed steady progress in anthropoid research. Of this, account will be taken in the later parts of this volume. Major problems of classification were solved, essential facts of distribution and ecological relations were gathered, the gross anatomy of each of the principal types of anthropoid ape was described with reasonable completeness and adequacy, and the scientific world gained familiarity with living specimens of the great apes in supplementation of its earlier acquaintance with skins, skeletons, and cadavers. Psychobiological studies even in the nineteenth century were few and of trivial importance. Consequently, except from naturalistic contributions, little was learned about the behavior and mental traits of the anthropoids.

We have achieved our main historical purpose of tracing the history of knowledge to the point of definite recognition of each of the anthropoid types, but before turning to our main interest, the behavior of the apes as made known to us through naturalistic observation and experimentation, we must examine somewhat more systematically and critically than heretofore terminology, types, and relations.

CHAPTER FIVE

TERMS, TYPES, AND RELATIONS

IN tracing the history of knowledge of the anthropoids we have found it necessary to refer frequently to important taxonomic and morphologic contributions. This is due to the interdependence of various lines of inquiry, their historical relations, and their common or overlapping terminology. The order of appearance of notable varieties of interest in anthropoid research, as previously suggested, seems to have been crude natural history (appearance and manner of life), classification, anatomy, physiology, behavior, and psychology. The student of behavior need not be also systematist and morphologist, but to ignore these disciplines with their highly developed techniques and their invaluable assemblages of information would be inexcusable.

It, therefore, seems desirable, in this our last historical and orientational chapter, to present briefly the derivation and meaning of certain recurrent popular and technical terms, and also certain essential information about anthropoid types and their obvious relations among themselves and to man.

The term primates, already repeatedly used by us without definition or apology, is derived from the Latin *primas,* first or chief. It was used by Linnaeus for the "highest" order of the mammalia, which according to his view included men, monkeys, lemurs, and bats (Homo, Simia, Lemur, and Vespertilio). According to the strength and quality of one's pride, this association of man with monkeys and bats may strike him as oddly interesting, humorous, or belittling.

As now defined, the order includes lemurs, monkeys, anthropoid apes, and men. The bats are omitted. There are two divisions, or suborders: the lemur-like animals (Lemuroidea), and the manlike animals (Anthropoidea), the monkeys, anthropoid apes, and man. Some authors recognize as a third suborder the Tarsioidea.

Few of the millions who familiarly use the terms ape and monkey are capable of defining them precisely. Indeed, it is not an easy task. Because of its more remote origin we should inquire first about the history and meaning of the word ape. It comes from the Old English, the masculine being *apa,* the feminine *ape* (*Murray Dict.*). Rennie (1838, p. 38) says of it:

> The word *ape,* which exists with little variation in all the modern European languages which have their origin in the ancient Teutonic, as *aap* in Dutch, *affe* in German, *apor* in Swedish, &c., is commonly supposed to be derived from the German word *affen,* to imitate (literally to *ape*); and in English is applied indiscriminately to all simiæ without tails, which are, on that account, generally considered to approach most nearly to the human form.

In following the usage of the word ape through the centuries one finds many entertaining reflections on the infrahuman primates. "Visage after martyn apen: Folke heo buth, ful eovel y-schapen!" (*K. Alis.* 6464, A.D. 1300.) "An ape vvilbe an ape, by kinde as they say, Though that ye clad him all in purple array." (Puttenham, *Eng. Poesie* [Arabic] 211 Prouerbe, 1589.)

Originally a generic term for manlike animal, ape later came to be restricted to such as lack tail and cheek pouches. Murray says of it: "An animal of the monkey tribe (*Simiadæ*); before the introduction of 'monkey' (16th c.), the generic name, and still (since 1700) sometimes so used poetically or rhetorically, or when their uncouth resemblance to men and mimicry of human action is the main idea. . . ." (*Murray Dict.,* cf. ape.)

Although the word continues to be used generically, the prevalent usage in America is for anthropoid ape. Since this meaning

seems to us for many reasons desirable, we have accepted it.

The adjective anthropoid, from the Greek and meaning "of human form," was early used to restrict the applicability of ape. Related terms, such as anthropomorpha and anthropomorphous (Linnaeus, 1735; Hoppius, 1760), appear in the literature. A century since, the term was used as in this volume. "A race of Anthropoids,—neither Raleigh nor Sidney would have called them Men—has wormed itself into the dominion of the letter-press—not the literature of England." (*Q. Rev.*, XLVIII [1832], 96.)

The usages of the following quotation have existed for centuries and they continue to be of interest and value.

> We say that an *ape* is a monkey without a tail, and a *baboon* a monkey with a short tail, reserving the term *monkey* more particularly for those species which have very long tails; and though our early writers use these three words indiscriminately . . . yet the significations here given have generally prevailed since the time of Ray. . . . (*Penny Cycl.*, II [1834], 144.)

Baboon, a term of uncertain origin, appearing in many ancient and modern languages, has been consistently used to designate the dog-faced monkey, called also by the ancients Cynocephalus.

Of the origin of the word monkey, which also has many spellings, we are ignorant. In one version of *Reynard the Fox* (1498) appears *Moneke* as the name of the son of Martin the ape. It is surmised that the term was brought to England by showmen from the Continent. Cognate terms are the French *monne* (sixteenth and seventeenth centuries), the Italian *monna*, and the Spanish and Portuguese *mona*.

Often today, as was true in previous centuries, the word is used generically for all the infrahuman primates, and again it is applied more specifically. We favor, and have adopted, the usage which excludes, on the one hand, the lemur-like primates, and on the other, the manlike forms (anthropoid apes), thus designating as monkeys all other primates.

The words simia and simian are so often used that they demand consideration. Rennie (1838, p. 35) is authority for the statement that they are generally thought to be derived from the Latin *simus*, meaning flat-nosed, though he admits that they may come from the Latin for mimic or *simulator*. Both meanings evidently are appropriate, since the primates are notorious imitators of one another and of man, as well as being flat-nosed.

Lichtenstein (1791), whose account of the terms used by the ancients to designate the primates is excellent, states that the word *simia* was used in three senses by Latin writers: (1) As a general term for all apes and monkeys; (2) for tailless apes, as distinguished from Cynocephali and Cercopitheci; and (3), for the single genus called by Linnaeus Sylvanus, as distinguished from Aegipan, Satyrus, and Sphinge. These different meanings, he remarks, were not recognized by the writers themselves.

Proceeding in this discussion from the general to the particular by way of such terms as primate, ape, and monkey, we come now to the names for those primates whose behavior is our subject matter.

Gibbon, although alleged to be an Indian word, has not been discovered in any Indian language (*Murray Dict.*). Buffon, whose scientific writings are the earliest in which we have discovered the term, states:

> *Gibbon* is the name by which M. Dupleix sent us this animal from the East-Indies. I thought at first that this was an Indian word, but in looking over the nomenclatura of the monkey tribe, I found a note of Dalechamp's upon Pliny, that Strabo has described the cephos by the word *Keipon*, from which, probably, *Guibon, Gibbon*, is derived. (Barr's *Buffon*, 1797, IX, 185, footnote.)

Rennie's account of the term is similar to and confirmatory of that of Buffon.

> The history of our knowledge of the gibbons, and other true apes, ascends to a more remote period of antiquity than has been hitherto suspected. The name *gibbon*, indeed, though of ancient origin, is modern in its application to the animals which now bear it; since we learn from Aristotle that the κῆβος, κῆπος, κεῖπος, or *cephus*, of the ancient Greeks and Romans, (a word itself

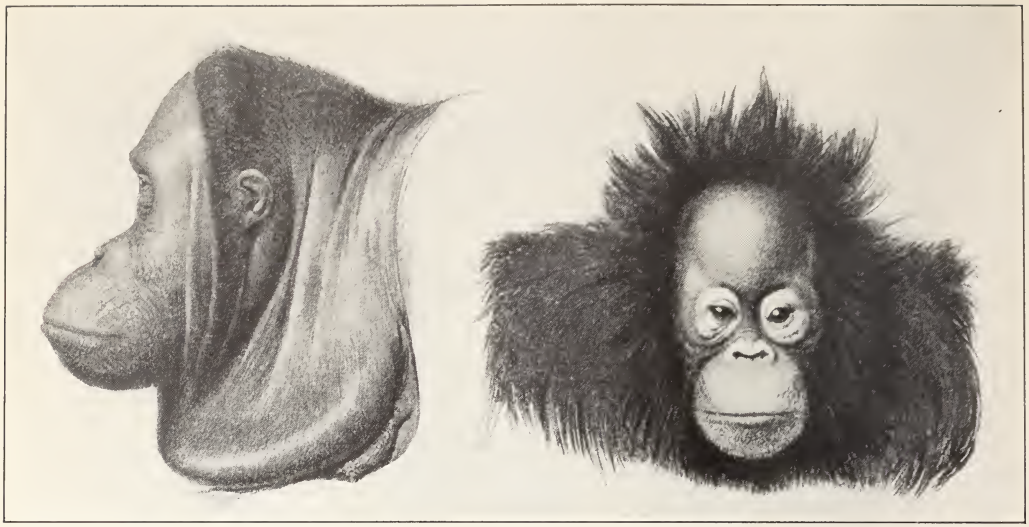


Fig. 25. Drawing of orang-outan heads. Adult (left), child (right). From Hermes, 1876.

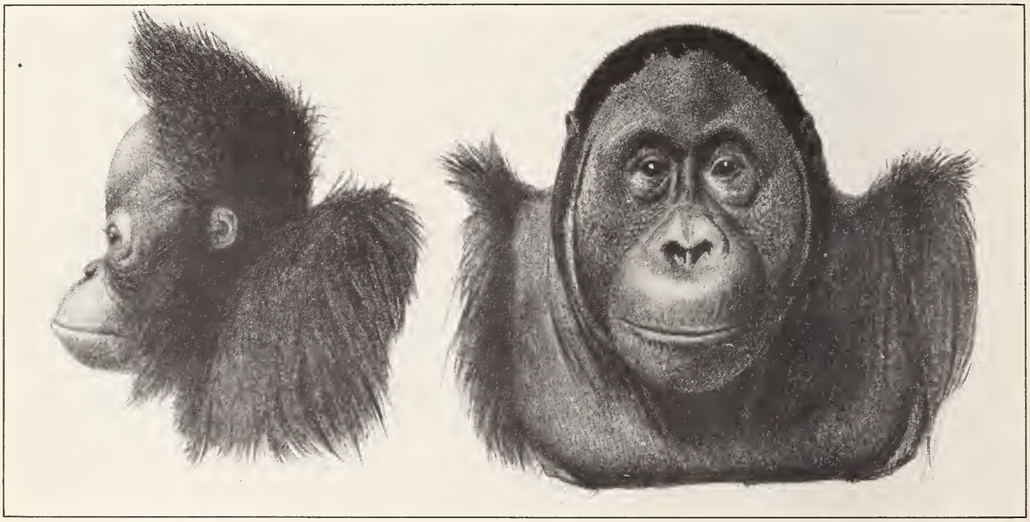


Fig. 26. Drawing of orang-outan heads. Adult (right), child (left). From Hermes, 1876.

clearly derived from the Hebrew קוֹף, *koph,*) had a long tail; but though it may have been originally misapplied to the *hylobates,* custom has so sanctioned its use, that it would now be difficult, even were it desirable, to change it. (Rennie, 1838, p. 146.)

Whatever its origin, gibbon is the common term for that family of apes which the taxonomist Illiger (1811) designated as Hylobates, a term which is truly descriptive, since it means tree-walkers. Both gibbon and Hylobates would be entirely satisfactory in their application were it not that some systematists have established two genera of gibbon, one of which they have called Hylobates, the other Symphalangus. This complication we shall consider later under types.

Orang-outan is an adaptation of two Malay words, orang meaning a reasonable being, and outan, of the woods or wild. It

is variously spelled, but Rennie (1838, p. 81) states as the correct form in English orang-outan. The first to record the name in scientific literature, as applied to the East Indian ape, is thought to be Bontius (1658). Systematists unfortunately have attached many names to the creature commonly known as orang-outan. Among them are Simia, Pithecus, Papio, Pongo. Had they consistently used the common name, endless confusion would have been avoided. As one reads the literature he comes to feel that too many authorities, each with the conviction that he may do as he likes about nomenclature, are worse than none.

Chimpanzee is thought to be derived from a native African word. It appears in several different spellings. The first which we have found is Quimpézé (de la Brosse, 1738). Matthews (1788) gives as alternatives Japanzee and Chimpanzee. That the word as now spelled, and with its present application to the smaller of the two African anthropoid apes, has been in use for approximately two centuries is indicated also by the following statement:

> A most surprizing creature is brought over in the Speaker, just arrived from Carolina, that was taken in a wood at Guinea. She is the Female of the Creature which the Angolans call Chimpanze, or the Mockman. (*Lond. Mag.*, September, 1738, p. 465.)

Even less fortunate than the orang-outan in its adventures with zoölogical names is the chimpanzee, for at various times and by diverse authorities it has been called Homo, Orang-outang, Pongo, Simia, Pithecus, Troglodytes, Pan, and by travelers or explorers Barys or Barris, Smitten, and yet other odd names.

Supposedly an African name for wild and hairy men, gorilla appears first in the account of Hanno's exploratory voyage, already quoted on page 3. Martin (1841, p. 372) tells us that the word gorilloi used by the translator of the Hanno record may be identical with Drill and Mandrill which are old African names still in certain places used for the chimpanzee.

By Savage and Wyman (1847) gorilla was selected as specific name for the new type of African ape which they mistakenly described as a species of chimpanzee. Subsequently it naturally became the name of the new anthropoid genus.

Reliable records seem to indicate that confusion of native African words and their adaptations is partially responsible for delay in the scientific identification of the chimpanzee as distinct from the Asiatic orang-outan, as well as in the discovery of the gorilla. *Engeco,* as used by Battell (Purchas, 1625); *Inchego* (Bowdich, 1819); *Enché-eco* (Savage and Wyman, 1847), and its corruption, Jocko, except as misapplied by Buffon (1789), Audebert (1800), and a few other authors, to the eastern orang-outan, certainly designate the chimpanzee. Likewise, Battell's term *Pongo,* presumably derived from the native tribal name Mpongwe; *Ingēna,* as used by Bowdich; *Engé-ena* of Savage and Wyman, and its corruption, *Gina,* unmistakably apply to the gorilla.

This hasty and incomplete examination of the history and meanings of terms which we shall many times use naturally leads to the principal problems of classification, nomenclature, and historical phases of their solution. It is no part of our task to outline the history of these problems, or to indicate in detail their present status. Instead it will suffice for our present need to illustrate stages of progress in the classification of the primates and to describe somewhat more fully the particular classification which we have selected for use.

For discussion of classification and nomenclature among the ancients we can cite no better authority than Lichtenstein (1791). With him we leave consideration of the prescientific period and pass to the contribution of Linnaeus. In the first edition of the famous *Systema naturae* (1735), Linnaeus applied the term Anthropomorpha to a group of animals consisting of men, monkeys, and sloths (*Homo, Simia, Bradypus*). In the tenth edition, 1758, Anthropomorpha is replaced by Primates, which includes four genera: men, monkeys,

lemurs, and bats. Even at that time many types or species of "Simia" were distinguished and with varying degrees of precision and adequacy described.

Cuvier, who was comparative anatomist and paleontologist, as well as taxonomist, in his *Leçons d'anatomie comparée* (1800) groups what we today know as primates in two families: I. Les Bimanes (two-handed), II. Les Quadrumanes (four-handed). The first family includes man alone. The second includes the monkeys (Simia) and the lemurs, as indicated in the following schema (see Gregory, 1910, p. 65).

Family I. Les Bimanes	Homme (Homo)	Homo
Family II. Les Quadrumanes	Singes (Simia)	Pithecus Callithrix Cercopithecus Cynocephalus Papio Cebus
	Makis (Lemur)	Lemur Indris Loris Galago Tarsius

The classification of Cuvier has been selected to indicate the status of primate taxonomy at the beginning of the nineteenth century. Similarly, that of Forbes, as given in his *Handbook to the Primates* (1894), may represent the end of the century.

> The Order PRIMATES, therefore, comprises two very homogeneous sub-orders—(1) The Lemur-like animals (LEMUROIDEA) including the Aye-Aye, the Tarsier, and the True Lemurs; and (2) the Man-like animals (the ANTHROPOIDEA), which embrace the Marmosets, the Baboons, the great Apes, and Man. (Forbes, I, 3.)

Commenting on the taxonomic relations of man, Forbes writes:

> Notwithstanding the numerous varieties and races of mankind distributed over every region of the globe, each exhibiting differences in habits, customs and superficial complexion, Man forms but one species, *Homo sapiens,* the sole representative of the unique genus of his family. (I, 1-2.)

Order Primates
- Suborder I. Lemuroidea
  - Tarsiers, Lorises, Lemurs
- Suborder II. Anthropoidea
  - Family 1. Hapalidæ
  - Family 2. Cebidæ
  - Family 3. Cercopithecidæ
  - Family 4. Simiidæ
  - Family 5. Hominidæ

Forbes's classification of the Simiidae or, in our terminology, anthropoid apes, follows:

Family Simiidæ
- I. HYLOBATES, Illiger
  - 1. agilis, F. Cuvier
  - 2. leuciscus (Schreber)
    - a. leuciscus (Schreber)
    - b. concolor, Schlegel
  - 3. leucogenys, Ogilby
  - 4. lar (L.)
  - 5. hoolock, Harlan
  - 6. hainanus, Thomas
  - 7. syndactylus (Desmarest)
- II. SIMIA, L.
  - 1. satyrus, L.
- III. GORILLA, Is. Geoffr.
  - 1. gorilla (Wyman)
- IV. ANTHROPOPITHECUS, de Blainville
  - 1. troglodytes (L.)
  - 2. calvus (Du Chaillu)

Including all of the gibbons in the genus Hylobates, Forbes describes seven species, of which one presents two subspecies. For the genus Simia (orang-outan) he gives but one species. Likewise for the genus Gorilla, only one species is described. In the genus Anthropopithecus (chimpanzee) two species are recognized.

In the decade between the publication of Forbes's handbook and the appearance of Max Weber's important volume on the mammalia (*Die Säugetiere,* 1904), comparative anatomy as basis for taxonomy progressed rapidly. Weber presents in masterly fashion an impressive assemblage of morphological facts, and in the light thereof a classification of the primates which in several respects differs radically from its predecessors. For example, the group primates is resolved into two orders, the Prosimiae and the Simiae. The latter in

WEBER'S CLASSIFICATION OF THE PRIMATES

Order	*Suborder*	*Family*	*Genus*
Primates	Prosimiæ	I. Tarsiidæ	
		II. Lemuridæ	
	Simiæ	I. Platyrrhina	
		1. Hapalidæ	
		2. Cebidæ	
		II. Catarrhina	
		1. Cercopithecidæ	
		2. Hylobatidæ	
		3. Anthropomorphæ	Genus Simia Linnaeus (orang-outan)
			S. satyrus Linnaeus
			S. abeli Clarke
			Genus Gorilla
			G. gorilla Wyman
			Genus Anthropopithecus de Blainville
			A. troglodytes Linnaeus
			A. calvus Du Chaillu
			A. (Troglodytes) tschego

turn is divided into the suborders Platyrrhina (monkeys with nostrils opening outward and separated by a broad septum) and Catarrhina (monkeys and apes with nostrils opening downward and separated by a narrow septum).

Instead of grouping all of the anthropoid apes in a single family, as does Forbes, Weber constitutes the gibbons a separate family called Hylobatidae, consisting of two groups, the gibbons and the siamangs, in a single genus. The remaining anthropoid apes he groups in the family Anthropomorphae, as is indicated in the above schema.

Weber's classification has the conspicuous merit of recognizing the striking morphological differences of the lemur-like animals, which he calls Prosimiae, from the true monkeys and apes, or Simiae; and likewise, the morphological gap between the gibbons and the three types of great ape. Although in several of the points above mentioned we consider his classification more satisfactory than that of Elliot (1913), we wish to present the latter because Elliot's *Review of the Primates* is an exceedingly useful assemblage of information to which we shall have occasion frequently to refer throughout this volume.

All of the classifications, as here presented, are incomplete; species ordinarily have been omitted, and, for all groups except the anthropoid apes, genera and in some instances even families.

In view of the extreme confusion of anthropoid types which has long obtained and persists even to this day, it would seem desirable to use consistently as generic terms, gibbon, orang-outan, chimpanzee, and gorilla, in preference to any of the taxonomic designations which have been proposed. Except, therefore, as we quote other authors or refer to specific classifications, we shall feel free throughout this work to use these familiar terms to designate types and shall ordinarily indicate

ELLIOT'S CLASSIFICATION OF THE PRIMATES

Order Primates
- Suborder I. Lemuroidea
- Suborder II. Anthropoidea
  - Family I. Callitrichidæ
  - Family II. Cebidæ
  - Family III. Lasiopygidæ
  - Family IV. Hylobatidæ
    - Genus I. Hylobates—Gibbons
    - Genus II. Symphalangus—Gibbons
  - Family V. Pongiidæ
    - Genus I. Pongo—Ourang-utan
    - Genus II. Gorilla—Gorilla
    - Genus III. Pseudogorilla—Mayema Ape
    - Genus IV. Pan—Chimpanzees
  - Family VI. Homonidæ

species or variety by prefixing or suffixing some generally known and widely accepted descriptive term. For example, we shall use Bornean orang instead of *Pongo pygmaeus, Simia pygmaeus,* or *Simia satyrus;* and Sumatran orang instead of *Pongo pygmaeus abelii, Simia abelii,* or *Simia bicolor.* Likewise, we may refer to the bald-headed chimpanzee or *Chimpanzee calvus* instead of *Pan calvus, Simia calvus, Anthropopithecus calvus,* or *Mimetes troglodytes.* The species koola-kamba we shall commonly designate as chimpanzee koola-kamba or simply koola-kamba, instead of by the Latin names *Pan koola-kamba, Troglodytes koola-kamba,* or *Simia koola-kamba.*

Since for the genus Gorilla, heaven be praised, the taxonomists have not created a multitude of names, we may safely use it in company with suitable specific term, or we may prefix a well-chosen descriptive term. Thus the most recently discovered gorilla type may be unequivocally designated as mountain gorilla or *Gorilla beringei.* Mountain is appropriate because of the nature of the animal's habitat; beringei, because it recognizes the discoverer, Captain von Beringe.

Division of the Hylobatidae into two genera, the Hylobates, the gibbons commonly so-called, and the Symphalangus, popularly known as siamangs, creates a difficulty, for no longer can the word gibbon safely be used generically as can orang, chimpanzee, and gorilla. For the present, however, it appears to us desirable to continue it as synonymous with Hylobatidae and thus inclusive of the siamang. Ordinarily, however, we shall apply the term siamang as well as a specific term to avoid possible confusion of this genus with Hylobates. Such popular terms as white-handed gibbon, instead of *Hylobates lar,* agile gibbon instead of *Hylobates agilis,* or hoolock instead of *Hylobates hoolock,* we shall feel entirely free to use.

Because behavior may vary with type (genus, species, variety) as with individuality, sex, stage of development, and physiological condition of the organism, it is essential that an animal which serves as object of study be so carefully and accu-

Fig. 27. White-cheeked gibbon, *Hylobates leucogenys.* From Sclater, 1877a, Proc. Zoöl. Soc. London.

rately described that it may be classified and safely compared with other individuals in the several respects mentioned. This necessity is the ground for the lively interest of students of behavior and psychobiologists in taxonomic method, discoveries, and nomenclature. As one step in what we conceive to be a profitable direction, we would now offer a general survey of the major divisions of the anthropoid apes, for, as we have already had reason to remark, definite and adequate descrip-

tion of an animal subject depends primarily on wisely selected and well-established principles of classification. To proceed, then, with our survey.

The gibbons clearly enough fall into two groups, recognized as genera by certain authorities. They are, as previously stated, the Hylobates, or true gibbons, and the siamangs. The former genus, called Hylobates by Elliot, includes some twelve species or varieties which differ chiefly in color markings, and are in such respect extremely variable. To include the siamangs, the genus Symphalangus has been established. In it there are three species or subspecies: *S. syndactylus* (formerly known as *Hylobates syndactylus, Simia syndactylus, Siamanga syndactyla,* and the Siamang gibbon), *S. s. continentis,* and *S. klossi.* The latter is said by Elliot to be a very small form of siamang, differing from the first species only in size.

The Hylobates and Siamangs differ chiefly in that the latter have a laryngeal sac which in Hylobates is lacking, are in general somewhat larger than Hylobates, and possess more pronounced supra-orbital ridges.

As one reads the taxonomic account of the Hylobatidae one wonders whether species-making has not been overdone and whether perhaps the great variation in color markings has misled observers.

Authorities are agreed that there is only one existent genus of orang-outan, and although for many years it has been suspected that there are two species, the one found in Borneo and the other in Sumatra, the fact is not perfectly established. By Elliot (1913) the Bornean orang is called *Pongo wurmbi,* and the Sumatran form *P. abelii.*

In the genus Chimpanzee, ten species have been described. By Elliot the following are listed. We shall take the liberty of using Chimpanzee as our generic term instead of Pan, which is Elliot's term. *C. calvus* (bald-headed chimpanzee), *C. fuliginosus, C. satyrus, C. kooloo-kamba, C. leucoprymnus, C. chimpanse, C. schweinfurthi, C. aubryi, C. vellerosus,* and *C. fuscus.* Although some of these species are well established, it is extremely difficult to identify and classify immature specimens. Consequently, students of behavior often find it next to impossible to designate the species of chimpanzee observed, or even to describe individuals in sufficient detail to enable the experienced systematist to do so.

The gorilla, like the orang-outan, seemingly varies markedly only in separated and differing habitats. There are two readily distinguishable forms: the lowland type, *Gorilla gorilla,* with a few subspecies or varieties, and the mountain type, *Gorilla beringei.* The difficulties which the student of behavior meets in his attempts to classify or describe the chimpanzee are absent in the case of the gorilla. But as between the two genera a new uncertainty arises, for there are evidences of the occurrence of intermediate forms. Several such individuals are mentioned in the anthropoid literature. Sometimes they are described as chimpanzees; sometimes, as gorillas. Elliot has set up the genus *Pseudogorilla,* with the single species, *mayema.* This rarely encountered intermediate form may be a hybrid between the gorilla and chimpanzee.

We have attempted to offer taxonomic orientation for students of anthropoid behavior and to recommend certain authorities and specific classifications which we believe may be relied upon and advantageously used. Similarly, we would now mention and recommend general morphological authorities and sources for those whose special psychobiological interests and inquiries may necessitate reasonably complete and detailed knowledge of the structure of anthropoid apes.

For general accounts of types, natural history, and structure, we would suggest Rennie (1838), Martin (1841), Vrolik (1841), Duvernoy (1855-56), Hartmann (1885), Keith (1896), Huxley (1863), and Heck (1922). The most convenient recent single source of morphological description is *The Morphology and Evolution of the Apes and Man* (1924) by Sonntag.

This work, although barely more than a syllabus, has many advantages for the student of behavior. Among them is the presentation of a list of more than five hundred references, chiefly to accounts of structure.

Of all the anthropoid apes the gibbons are least like man, structurally and in behavior. Next, in order of increasing resemblance, comes the orang-outan, while the chimpanzee and gorilla compete for first place. In some respects the one, and in some the other, is the more like man. In order of lessening structural fitness for arboreal life, the anthropoid types rank: gibbon, orang-outan, chimpanzee, gorilla. As between the orang and chimpanzee there is not much to choose, but there is a vast difference between gibbon and gorilla. Even the superficial observer notes indications of family relationship between gorilla and chimpanzee, whereas the gibbons seem much more remotely related to the other anthropoid apes and to man.

As we may not offer even a general account of the status of knowledge of the genetic relations of anthropoid types, we must again have recourse to the citation of authorities. There is no dearth of interesting and useful discussions of the subject, but there is complete lack of definite information. Together with many ingenious theories and much speculation, we find precious fragments of information in almost all divisions of biological science. Presently we may reasonably expect these fragments to fit together into a consistent and intelligible whole which will enable us to read accurately the genetic history of anthropoid types and of man.

Morphological facts indicate that although the anthropoid apes are more like man than are any other animals, and that their order of increasing resemblance is gibbon, orang, chimpanzee, and gorilla, there is little likelihood of human origin or descent from any one of the existing types. Instead all are believed to have developed from a common ancestral form which is now extinct.

As facts of behavior and of psychobiological status may presently throw new and important light on the chief problems of primate relationships and human origins, and as in such case it will be desirable for us to have clearly in mind theories of descent and ancestral schemata which have been inspired primarily by consideration of morphological facts, we venture to present, with proper acknowledgments to the author, and as an example, the tentative scheme of relationships within the order primates constructed by G. Elliot Smith.

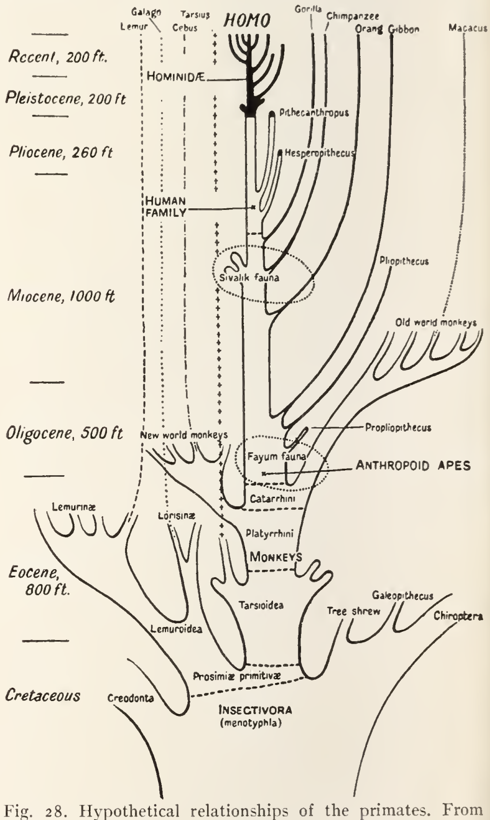


Fig. 28. Hypothetical relationships of the primates. From G. Elliot Smith, 1924. Courtesy of Oxford University Press.

We have discussed terms, types, and relations as preparation for examination of the facts of anthropoid behavior, and to aid us in understanding, evaluating, and using them. We shall now enter upon our main task, the critical examination of available records of anthropoid life in order to construct therefrom safe and as nearly as may be accurate description of the life history and action-systems of the several types of anthropoid ape.

PART II

GIBBON

GIBBON

CHAPTER SIX

THE HABITS AND LIFE HISTORY OF GIBBON

WITH a classification dictated by what we conceive to be psychobiological interests, we have arranged the data of gibbon behavior in three chapters. In the first are presented the essential and fairly well-established facts of natural history, including distribution, habitat, habits, and life history; in the second, a description of emotional life and expressions in the gibbon; and in the third, an account of receptivity and adaptivity. In thus segregating our naturalistic materials and arranging them in psychobiological categories, we have, it is true, departed from the time-honored practice of systematists, naturalists, and general zoölogists. We hope that the method of presentation may prove convenient as well as logical and especially that it may serve to reveal and emphasize the gaps in our knowledge, unsolved problems which should be attacked, and opportunities and needs for naturalistic and experimental inquiry. Throughout the chapters we have added to what we found in the literature on gibbons our own observations, often unrecorded, and other pertinent data which in various ways we have been able to assemble. Consequently our description, although primarily historical, is also in a measure original and calculated to advance knowledge rather than merely to indicate its present status.

HISTORICAL SUMMARY

ALTHOUGH acquaintance with the gibbon may be traced back some twenty-five centuries, scientific knowledge is both young and immature. A *résumé* of the statements scattered through our previous chapters may be serviceable.

Whereas the comments of Aristotle do not convince us that gibbons were known in his time, the evidences in Pliny and Galen are more varied, positive, and useful. Indeed, we feel reasonably assured that Pliny wrote of the gibbon and that Galen dissected it. Marco Polo's reference, in the thirteenth century, to manlike animals is chronologically next in order. Then follow the historical accounts of Gesner (1551) and Aldrovandi (1637). They effectively perpetuated but added nothing to the knowledge of the ancients. The description offered by Le Comte (1697) unmistakably applies to the gibbon. But perhaps the birth of scientific description should be dated from the publication in 1766 of the fourteenth volume of Buffon's *Natural History* rather than from the writing of Le Comte.

Shortly after the publication of Buffon's famous volume appeared de Visme's (1769) illustrated account of the gibbon. The references of Turpin (1771) and Charles Miller (1778) are unimportant, but van Iperen and Schouman in 1784 supplied a really useful description of the wau-wau, and Audebert (1800) presented the excellent illustrations which we reproduce as figures 20 and 21, p. 28.

Early in the nineteenth century interest in the gibbon family appears to have increased, and there were published several scientific contributions, including those of Raffles (1822), E. Geoffroy-Saint-Hilaire and F. Cuvier (1824), and Horsfield (1824).

As in the previous part of this volume we have endeavored to survey the prescientific period of anthropoid inquiry, in the present part we shall feel free to devote our

attention primarily to the content of scientific contributions and to endeavor to give a connected account of the information which has become available.

More illuminating than much that has since been written is Le Comte's description of "a species of ape." It is an admirable introduction to gibbon behavior.

For myself, in passing from China to the coast of Coromandel, I saw in the Strait of Malacca a species of ape. . . .

This animal walked naturally on its two hind legs, which it bent ever so little, like a dog that has been taught to dance. It made use of its two arms as we do; its face was fashioned almost exactly like those of the savages at the Cape of Good Hope; but its whole body was covered with white, black, or gray wool: nevertheless its cry was exactly like that of a child; all of its external behavior was so human and its passions so lively and striking that even dumb men could have expressed their sentiments and wishes little better. They seemed to be above all of a very tender disposition, and to show their affection toward those whom they knew and loved, they embraced and kissed them with surprising transports. They have an action which is not found in any other animal, and which is characteristic of children; that is, to stamp with joy or with displeasure, when they are given or refused something for which they have a passionate longing.

Although they are very large (for those I saw were at least four feet high) their nimbleness and adroitness are incredible. It is a pleasure beyond expression to see them run up the tackling of a ship, where they sometimes play, as if they were especially made for the art of vaulting; or as if they had been paid, like our rope-dancers, to amuse the company.

Sometimes suspended by one arm, they balance themselves for some time nonchalantly to try themselves, and then turn, all of a sudden, around a rope, with the rapidity of a wheel, or a sling that is put in motion; sometimes holding the rope successively with their long fingers, and letting themselves drop into the air, they run with full speed from one to the other, and return with the same speed. There is no posture they cannot imitate, nor any motion they cannot perform; bending themselves like a bow, rolling like a bowl, hanging by their hands, feet, and teeth, according to the different fancies with which their bizarre imagination furnishes them, and which they perform in the most diverting manner in the world: but their ability to fling themselves from one rope to another, at a distance of thirty or forty feet, seems still more surprising. (Le Comte, 1697, II, 362-364.)

A full century later there appeared in Latreille's *Buffon* (1799-1808, XXXV, 140) another typical naturalistic account of the gibbon. We quote it from Harlan's translation.

"This Orang-outang, named Voulock [Hoolock] in its native country, was a female, and regularly menstruated, but the discharge was interrupted after the attack of scurvy. She was of a very gentle disposition, only monkeys displeased her, whose presence she could not endure. She always walked in the upright attitude, and could even run very fast: when walking on a table, or among china-ware, she was very careful not to break any thing; when climbing she used only her hands; her knees resembled those of man. Her cry was sharp and deafening, pronouncing often and frequently repeating the syllables yaa-hoo! yaa-hoo! yaa-hoo!—with the emphasis on the last syllable, particularly on the terminal sound: when she heard any noise resembling this, she commenced crying also. When contented, she emitted a low guttural sound. When sick she whined like a child, and was fond of being nursed. Her food consisted principally of vegetables and milk; she would never touch a dead animal, or eat meat, and refused even to eat from a plate which had contained meat" [in this respect she differed from those individuals in the possession of Dr Burrough, these latter would eat meat occasionally]. "When thirsty, she plunged her fingers into the water and licked them: she voluntarily covered herself with pieces of sail-cloth, but would not endure clothes. She would come when called by name. She was commonly melancholy and pensive." (Harlan, 1834, p. 53.)

Keith, who in 1896 prepared a summary digest of the scientific literature on the gibbon, deplored the paucity of data on this family of anthropoid apes and remarked that it is not due to lack of opportunity for study, since in recent years there have been thirty-five specimens belonging to different species of gibbon in the Zoölogical Gardens of London.

Our knowledge of its anatomy is based upon a very small amount of material. Until five years ago, when Kohlbrügge published dissections of four specimens, our information was confined to incomplete descriptions of the anatomy of five animals. . . . After their arrival in Europe, they are soon at the disposal of the dissector, for unfortunately they do not live long in confinement, few of them more than a year. Of three gibbons that were in the Rotterdam gardens, two lived for about a month, the other died after a sojourn of eight days. (Keith, 1896, p. 372.)

If the systematists and morphologists may reasonably complain of meager information concerning gibbons, much more so may the psychobiologist, for whereas there are now several excellent anatomical publications on this family of apes, there are only a few first-rate naturalistic descriptions and only two experimental studies of behavior which are worthy of attention. One marvels at the fact and wonders why no enterprising biologist has intensively studied the natural history of the gibbon. Although not an easy task it should be alluring, because of the characteristics of the animal itself and the historical failures.

STRUCTURAL CHARACTERS

Smallest of the anthropoid apes, and in many aspects of structure as well as behavior least manlike, the gibbons are distinguished from the other anthropoids by the presence of small ischial callosities, shape of skull and facial contour, color and texture of skin and hair, relative length of arms, degree of arborealness, and posture in climbing, walking, and resting.

In height, the full-grown gibbon, with the exception of the siamang which is considerably larger, seldom exceeds three feet. The animals are very slender, with chest well developed, but abdomen constricted and likened by some authorities to that of the greyhound. The latter contrasts almost ludicrously with that of the gorilla which is extremely large. The weight of the creatures, rarely given by observers, is surprisingly slight. Hornaday supplies the following measurements for "the largest specimen I measured in Borneo": head and body, 19 inches; extent of outstretched arms and hands, 5 feet 1 inch; entire reach of arms and legs, 5 feet 1 inch; hand, 6½ inches long by 1 inch wide; weight, 10¼ pounds (Hornaday, 1904, p. 12); and Keith (1895, p. 292) gives the body weight of the gibbon as about 12 pounds, and for the siamang about 21 pounds.

The lay observer is always struck by the great length of arm in the gibbon. According to Huxley (1863, pp. 23-24) the proportion of arm length to leg length is exceeded only by the orang-outan, while the proportion of arm length to body length is greater in the gibbon than in any other anthropoid ape. So long are the arms that as the animal walks upright the fingers in some cases nearly touch the ground. The hand is very long and narrow, exceeding the foot in length. Both the thumb and the great toe are widely separated from the next digit. The great toe is well developed and may be nearly half as long as the foot. In the siamang, regularly, and occasionally in other members of the gibbon family, the second and third toes are connected with a web or fused completely.

The head is variously described as roundish or egg-shaped. The latter term seems to us more strictly applicable. The face by many observers has been characterized as more like the human, for the nose is more prominent than is the case in any other ape, and the nostrils, opening downward and outward, increase the similarity to man. The teeth are said to appear slowly and relatively late in the period of development. We have failed to find entirely satisfactory authority for this statement and the observational data are far from adequate. The canine teeth are large.

Of all the anthropoid apes the true gibbon alone, and here the siamang is again an exception, lacks that peculiar structure which is called laryngeal sac. In the siamang the structure is conspicuously present and functions apparently in connection with vocalization.

The skin ordinarily is black and carries a coat of hair which is characteristically thick, deep, and woolly in the gibbons proper. Its color ranges from black, through brown, straw-colored, and gray, to snow-white. In some members of the family, the hands, feet, face, and breast are naked; and in the siamang the skin covering the laryngeal sac, as well as that of the face, hands, and feet, is relatively free of hair.

The brain of the gibbon differs less in shape, size, and proportions from that of the monkeys than do those of other an-

thropoid apes. The surface is said to be less rich in convolutions and sulci and the frontal lobes to be more flattened. It is said

Fig. 29. Siamang, with laryngeal sac inflated. Courtesy of F. W. Bond, photographer, and Zoölogical Society of London.

also that the occipital lobes of the cerebrum are smaller than in the other anthropoids.

For supplementation of this brief structural description we would refer the reader to Sonntag (1924) and to morphological authorities mentioned in his extensive bibliography.

Because the siamang differs so strikingly from the other gibbons it is desirable to characterize it separately. It is both taller and heavier than the gibbon proper, with jet-black skin and hair, the latter being coarser and rougher than in Hylobates. The skin of the throat is bare and distensible over the large laryngeal sac. The second and middle toes are united as far as the last joint. The skull is larger and the supra-orbital ridges more highly developed than in gibbons. The arms are, relatively, shorter. Forbes (1894, II, 167) states that the frontal lobes of the brain are flat, and that the olfactory bulbs extend forward beyond them. The occipital lobes are small, and the cerebellum projects from beneath the cerebrum. But among all these structural peculiarities, the outstanding characteristic of the siamang, the one by which it may most easily be distinguished from other members of the large family, is the naked skin covering the laryngeal sac. When this is distended in the use of the sac the appearance of the animal is extraordinarily distinctive.

DISTRIBUTION, HABITAT, AND SPECIES

The gibbon family is strictly oriental and inhabits the Indian zoögeographical region. Its distribution is of particular interest in relation to species formation and modification. By one or another species it is represented in southern China, the Malay Peninsula, the Malay Archipelago, and the Island of Hainan.

In the latest edition of Brehm's *Tierleben* (1922), Heck[1] recognizes as established and worthy of naturalistic descrip-

Fig. 30. Siamang, with laryngeal sac partially inflated. Courtesy of New York Zoölogical Society, E. R. Sanborn, photographer.

[1] In the fourth edition of Brehm's *Tierleben*, L. Heck is responsible for the section on Primates.

tion four species of Hylobates: *H. hoolock, H. lar, H. agilis,* and *H. leuciscus,* in addition to the genus Siamanga. Writing somewhat more recently (1924, pp. 73-74), and with quite different purpose, Sonntag recognizes the siamang and eight species of Hylobates: *H. hainanus, H. lar, H. agilis, H. pileatus, H. muelleri, H. leuciscus, H. hoolock,* and *H. leucogenys.* Of the twelve species described by Elliot (1913) three or four are decidedly questionable.

As distribution, habitat, and behavior differ significantly for the various species, it is necessary at this point to list them under the common names which we have adopted for use in this volume and to present certain essential information concerning each. Because of the multiplicity of species names and the persistence of confusion of types it is necessary also to present the more important recent synonyms.

1. Agile gibbon = *Hylobates agilis* F. Cuvier = *H. lar* = *H. variegatus* = *H. rafflesii* = *H. unko* = *H. pileatus* = Slender gibbon = Active gibbon. Found exclusively in Sumatra and Siam (Forbes, 1894, II, 153), or in Sumatra alone (Elliot, 1913, III, 169; Martin, 1841, p. 425).

The agile gibbon varies markedly in coloration and in consequence has been the subject of much discussion and the cause of confusion.

2. Bornean gibbon = *Hylobates concolor* Harlan = *H. harlani* = *H. mülleri* = *H. funereus* = Müller's gibbon. Found in Borneo. This species also is subject to color variations which are imperfectly known and still less understood.

3. Hainan gibbon = *Hylobates nasutus* Künckel = *H. pileatus* = *H. hainanus.* Found in the Island of Hainan and Cochin China (Elliot, 1913, III, 155).

4. Hoolock = *Hylobates hoolock* Harlan = *H. hulok* = *H. choromandus* = *H. niger.* Found in the Malay Peninsula (?) (Upper Assam, Aracan, Yunnan).

5. Siamese gibbon = *Hylobates pileatus* Gray = *H. agilis.* Found, according to Elliot (1913, III, 170), in Cambodgia; Paknam Kabin, Siam; Cochin China.

6. Wau-wau = *Hylobates leuciscus* Geoffroy = *H. javanicus* = Silver, silvery, or gray gibbon. Found in Java.

7. White-cheeked gibbon = *Hylobates leucogenys* Ogilby. Found in Siam.

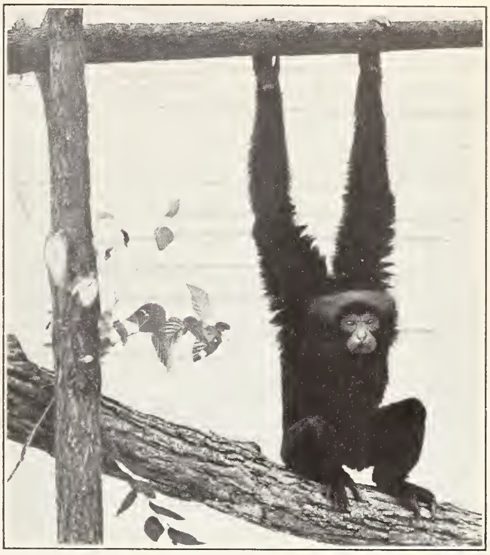


Fig. 31. Female siamang, about five years old. Courtesy of New York Zoölogical Society, E. R. Sanborn, photographer.

8. White-handed gibbon = *Hylobates lar* Linnaeus = *H. variegatus* = *H. albimanus* = *H. unko* = *H. leuciscus* = *H. entelloides* = *H. agilis.* Found in India: Tenasserim, Malay Peninsula.

Siamang = *Symphalangus syndactylus* = *Hylobates syndactylus* = *Siamanga syndactyla.* Found in Sumatra and possibly also in the Malay Peninsula (Elliot, 1913, III, 177).

All of the species of Hylobates are found in upland forests at elevations ranging, according to different observers and for the different species, from four or five hundred to five thousand feet above sea level. Our primary authorities for this statement are Tickell (1865), Anderson (1878), and Blanford (1889-91). The siamangs alone frequent sea level and the coast. Heck (1922, p. 614), on the authority of one Wray, states that the true gibbons avoid altitudes greater than four thousand feet and correspondingly cold re-

gions, while a species of siamang ascends as high as seven thousand feet in the mountains of the Malay Peninsula. Its coat, presumably adapted to the high altitude tem-

Fig. 32. Adult female wau-wau, *H. leuciscus*. Courtesy of H. C. Bingham and the Century Company.

peratures, is described as long and rough. The description suggests that this type of siamang is comparable in its environmental relations and adaptations to the mountain species of gorilla and that both are high altitude types.

By one authority the reader is assured that gibbons are much alike in all essentials, and by another that they differ importantly. Perhaps the contradiction is due in large part to the now well-recognized variations in coloration and color pattern in both genus and species. From the data we have succeeded in assembling it is clear that color varies with species, individual, sex, developmental stage, and perhaps also climatic and nutritional conditions. Probably the facts would be difficult enough to understand if completely observed even in a single well-defined species. It is no wonder, then, that the systematists have been puzzled by the extreme differences in the coloration of specimens from the same geographical region and presumably representing the same species.

Forbes, writing in 1894, describes the coloration of the several species of Hylobates with simplicity and definiteness. Elliot in 1913 offers more elaborate descriptions and is much less certain of the adequacy of his knowledge. The siamangs and several types of gibbon at one time or another in their life history are jet-black. The wau-wau is typically ashy gray in coat color, and in certain other species there is a considerable range of color, combined with a complex and variable pattern. Gradually naturalists and systematists have come to appreciate the risk of basing species on coat characters; but we are still, it appears from the literature, far from an intelligent understanding of the facts, relations, and causes of coat color and pattern in these highly interesting apes.

Relations of coloration to sex and age are well established. Pocock (1905, p. 172) is authority for the statement that an adolescent female Hainan gibbon which when first observed was dark smoky gray, shortly after arrival at the London Zoölogical Gardens became light gray. The change apparently coincided with sexual maturity. Swinhoe (1870, p. 224) states that in this species the males are black and the females white.

Of the hoolock, Sanyal (1907, p. 277) writes that:

The species may be divided into the four following groups:

(1) Light-coloured female hoolocks turning grey, or even white with age.
(2) Black, or grey-coloured female hoolocks, becoming lighter grey or white with age.
(3) Black female hoolocks never turning grey or white.
(4) Light-coloured, or grey males, remaining always the same colour.

In an unpublished manuscript Mrs. Reynold A. Spaeth, from data preserved in the notes of the late Dr. Spaeth, asserts that in the gibbons of Siam as a rule the males are dark and the females light in coloration, and that among young ones the males are gray and the females buff. Exceptions to this rule are noted.

It also is established that in certain at least of the species of Hylobates sexual dimorphism does not appear until relatively late in development and that the sexes consequently are confused during early life and the phenomena of coloration, therefore, are not readily related to sex.

In 1830, George Bennett acquired in Singapore a specimen of siamang which he describes as a castrated Ungka ape. The anthropometric data presented, and the following sentence, "The animal had been castrated, but the spermatic cord terminated in the scrotum in two small oval substances, rather larger than small peas" (Bennett, 1834, II, 171), justify the conclusion that it was a young male siamang in which the primary sex characters were only partially developed. Our inference is supported by the observations of Pocock, who states that the male gibbon, owing to the relatively late appearance of sexual dimorphism, is often mistaken by scientists as well as laymen for either a castrated individual or a female, and the female for a castrated male (Pocock, 1905, p. 171, and more recently by Welch, 1911, pp. 353 ff.). This matter is of peculiar interest and importance because sex, age, and physiological condition are as important in connection with descriptions of behavior as are species differences.

HABITS OF LOCOMOTION

Little is definitely known of the daily life of wild gibbons. Of the half score or so of competent naturalistic observers who have contributed to our knowledge, not one has pursued his inquiry long enough or extensively enough to obtain a reasonably complete and well-correlated account. The following passage from Anderson is typical of the descriptions to be found in the best scientific contributions.

> It was early morning and the air was resonant with the loud calls of this Gibbon; large troops were answering each other from the opposite banks, and the hills echoed and re-echoed the sound. The Hoolock is also common on the Kakhyen hills, on the eastern frontier of Yunnan; and, there, too, my attention was called to them at daybreak when they passed up from their sheltered sleeping-ground in the deep and warm valleys to heights of about 4,000 feet. We, in the middle distance, first caught a faint murmur of voices; but every minute it became more and more distinct, till at last the whole troop rushed past in a storm of sound, vociferating "whoko!" "whoko!" and in a few more minutes their cry was heard far up the mountain-side. Considering that their progress is almost exclusively arboreal, the rapidity with which they make their ascent is wonderful. (Anderson, 1878, I, 2.)

One may infer from this statement, and similar observations of other authorities, that the animals generally spend the night in sheltered regions and during the day ascend the hills or mountains in search of food.

The name Hylobates is appropriate because gibbons are highly arboreal creatures. They are well fitted structurally for life in trees, whereas on the ground they are at a disadvantage. Almost every naturalist who has written about them has described their mode of progress through trees and also their way of walking. The following general statements seem to apply to all of the species of Hylobates, but the heavier and less agile siamang cannot safely be included.

All observers agree with Anderson that the progress of gibbons through the trees is marvelously rapid. They use their arms to swing themselves from branch to branch instead of jumping or springing. It is said that they cover distances of thirty, or even forty, feet without evident difficulty or hesitation. They can change direction of motion while in the air and on landing are able to take a fresh start instantly. Indeed, their locomotion has been likened by many observers to the flight of a bird.

Martin, whose general account of the genus Hylobates is at least the equal of

any available, thus describes the "agility, power, and address" of a specimen of the agile gibbon which was exhibited in London in 1840.

Fig. 33. The same wau-wau as that in fig. 32. Courtesy of H. C. Bingham and Mrs. R. Abreu.

When at rest, her favourite position is that of sitting in a crouched attitude, at the fork of one of the branches of the tree in her spacious apartment, so as almost to shroud herself from view; and from this post she watches intently everything that passes around, or the motions of any person endeavouring to gain a sight of her. It is not without impatience that she submits to discipline: she has often turned upon her keeper with every demonstration of anger, and engaged with him in a struggle for the mastery. It is almost impossible to convey in words an idea of the quickness and graceful address of her movements: they may, indeed, be termed aërial, as she seems merely to touch, in her progress, the branches among which she exhibits her evolutions. In these feats her hands and arms are the sole organs of locomotion; her body hanging, as if suspended by a rope, sustained by one hand (the right, for example), she launches herself, by an energetic movement, to a distant branch, which she catches with the left hand: but her hold is less than momentary; the impulse for the next launch is acquired: the branch then aimed at is attained by the right hand again, and quitted instantaneously, and so on, in alternate succession. In this manner, spaces of twelve and eighteen feet are cleared with the greatest ease, and uninterruptedly, for hours together, without the slightest appearance of fatigue being manifested: and it is evident, that if more space could be allowed, distances very greatly exceeding eighteen feet would be as easily cleared; so that Duvaucel's assertion, that he has seen these animals launch themselves from one branch to another, forty feet asunder, startling as it is, may be well credited. Sometimes, on seizing a branch in her progress, she will throw herself, by the power of one arm only, completely round it, making a revolution with such rapidity as almost to deceive the eye, and continue her progress with undiminished velocity. It is singular to observe how suddenly this Gibbon can stop, when the impetus, given by the rapidity and distance of her swinging leaps, would seem to require a gradual abatement of her movements. In the very midst of her flight a branch is seized, the body raised, and she is seen, as if by magic, quietly seated on it, grasping it with her feet. As suddenly she again throws herself into action.

The following facts will convey some notion of her dexterity and quickness. A live bird was let loose in her apartment; she marked its flight, made a long swing to a distant branch, caught the bird with one hand in her passage, and attained the branch with her other hand; her aim, both at the bird and the branch, being as successful as if one object only had engaged her attention. It may be added, that she instantly bit off the head of the bird, picked its feathers, and then threw it down, without attempting to eat it.

On another occasion, this animal swung herself from a perch, across a passage, at least twelve feet wide, against a window, which it was thought would be immediately broken; but not so: to the surprise of all, she caught the narrow frame-work between two panes with her hand, in an instant attained the proper impetus, and sprang back again to the cage she left—a feat requiring, not only great strength, but the nicest precision. She is fond of fruit, and often displays her dexterity in catching apples or plums, purposely thrown at her: however quickly they may be propelled by a vigorous arm, and although pretended throws may be made, to deceive or balk her, she never fails to catch the fruit, and that almost without an effort. (Martin, 1841, pp. 429-431.)

So far as we have been able to discover, no study of any aspect of the remarkable translational activity of the gibbon has ever been made under carefully arranged experimental conditions. The measurements which might thus be obtained are much to be desired.

That specific differences in agility have been noted is indicated by Tickell (1865, p. 197), who says that the white-handed

gibbon is not nearly so active and lively as the hoolock. Several authorities state that siamangs move more slowly and are somewhat less sure in their climbing than are the species of Hylobates.

It is certain that gibbons climb with facility and swing about in the forests with assurance and in such wise as to make rapid progress if they so desire. But when it comes to movement on the ground there is considerable variation in the descriptions which we have assembled. Almost all authorities agree that the general attitude in walking is erect with the soles of the feet placed flat on the ground, and the arms held either above the head where they wave in the air, or bent sharply at the elbow. By some it is assumed that the arms are used to aid in balancing, by others that this is a minor function and that they are merely held up out of the way. Again, some observers state that the animals can walk with rapidity and ease if not frightened or hurried, whereas others consider this mode of progression difficult, unnatural, and fatiguing. It is also said that if frightened or for any other reason hurried, the gibbon either hops along excitedly or takes to quadrupedal locomotion.

Certain comparisons offered by Pocock (1905) in an excellent article on the behavior of a female specimen of the Hainan gibbon are pertinent. This author says gibbons are unequaled among the anthropoid apes for proficiency in use of arms in arboreal progression and in use of legs in terrestrial progression. Their bipedal ability is surpassed only by that of man. In fact, Pocock's description, comparison, and discussion of locomotion in the four types of anthropoid ape are at once so consistent with the data which we have assembled, so instructive, and so suggestive of genetic problems, that we quote him at length.

If the Anthropoid Apes be ranged in series according to proficiency in bipedal locomotion, the order will be (1) Gibbons, (2) Gorillas, (3) Chimpanzees, (4) Orangs. Gibbons not only stand erect and habitually walk without putting the hands to the ground; they can even run with astonishing speed, a speed indeed comparable to that of Man, allowance being made for difference in size. Like Man they race away when scared; and, unlike the other Anthropoid Apes, they do not use their arms as crutches. Sometimes also, but rarely, they leap over the ground with both feet together.[2]

Gorillas can stand and walk upright, but not with the ease of Gibbons, and it may be doubted if they ever run erect or leap, *i.e.,* progress with both feet off the ground at one time; and they probably never run from danger, standing upright, as Man and Gibbons do. Their usual walk is quadrupedal.

Chimpanzees, too, are essentially quadrupedal; and under ordinary conditions, and when in perfect health, almost always get over the ground on "all fours," like a Baboon or Rhesus. In this respect, indeed, they more resemble the Cercopithecoid Monkeys than does any other Anthropoid Ape; and they are able to cover the ground with much greater speed than either Gorillas or Orang-Utans; but I am unable to say if their quadrupedal method is so fast as the bipedal method of Gibbons. Like Baboons, they can stand erect and walk to a certain extent, but not with the facility of Gorillas.

The gait of young Orang-Utans may be described as a clumsy quadrupedal shuffle. I never saw one stand unsupported by the arms. Weakness of leg and weight of body make exclusively bipedal action, if not an impossibility, at least so great an effort that it may be doubted if it is ever resorted to. Their whole organisation suggests unfitness for terrestrial locomotion.

Thus, if the Apes be classified according to their quadrupedal activity on the ground, they will stand: (1) Chimpanzees, (2) Gorillas, (3) Orangs, (4) Gibbons.

It is interesting to compare this series with one based upon dexterity in climbing and addiction to arboreal life. It is: (1) Gibbons, (2) Orangs, (3) Chimpanzees, (4) Gorillas. The Gibbons stand quite alone both in method and expertness; the others differ *inter se* merely in degree.

The foregoing results may be briefly summarised as follows:—The Gibbons are the most expert climbers and bipedal walkers, the least expert quadrupedal walkers. The Orangs rank second in climbing, third in quadrupedal and fourth and last in bipedal activity. The Gorillas take fourth place in climbing, second in bipedal and second in quadrupedal activity. The Chimpanzees stand third in climbing, third in bipedal and first in quadrupedal powers.

Since, therefore, the action of Monkeys, whether Cercopithecidæ, Cebidæ, or Hapalidæ, and of Lemurs is essentially quadrupedal, the fore and hind

[2] "These and the following statements and reflections are based upon my own observations of the Anthropoid Apes that have come under my notice in the Society's Gardens."

limbs being used to an approximately equal extent, both in terrestrial and arboreal locomotion, it may be inferred that the Chimpanzees have departed least in these respects from the primitive Primate stock; the Gorillas a little more in the line of bipedal erection and, concomitantly, loss of climbing power; the Orangs still more in the direction of loss of terrestrial activity and increase of arboreal expertness; the Gibbons most of all in the line of bipedal activity, dexterity in hand-climbing, and loss of quadrupedal power.

This serial arrangement of the Apes is the exact opposite of the one prevalent in text-books, where the order adopted is based upon structure with Man placed first as the standard for comparison. It suggests that for the origin of Gibbons we must look not to forms resembling any known Cercopithecoid type, but to forms which had already acquired the Simiine or Anthropomorphine characteristics and had either lost or never learnt the method and skill in climbing found in the former group. They may have started from a type somewhat on a level with the Chimpanzees with respect to terrestrial and arboreal activity; and to swing with greater facility from tree to tree and to obviate the risk of injury in case of a fall, it is highly probable that they have become dwarfed in stature and grown lighter in build. Their muscularity and length of arm, slightness of body and strength of leg, all factors of importance in enabling them to traverse the jungle and, in case of a miss or a breaking branch, to drop lightly to the ground and run to the nearest tree for safety, were probably perfected concomitantly. That Gibbons are able to drop with safety a considerable distance is substantiated by the fact that Mr. de St. Croix has seen his specimen come to the ground without injury from a height of about 20 feet. When leaping to the ground Gibbons swiftly draw up the knees as the feet touch, exactly as a man does under similar circumstances, to break the shock. (Pocock, 1905, pp. 178-179.)

When resting the gibbon ordinarily sits hunched up in the crotch of a tree, with its long arms folded across in front of it and sometimes resting on the knees, the head bent forward and the chin nearly in contact with the drawn-up knees and folded arms. Those who have observed it in captivity frequently state that in sleeping it lies stretched out on back or side. The evidence suggests that this is an adaptation to the conditions in captivity instead of the natural attitude in quiescence or sleep. By several observers it is stated that the animal readily becomes accustomed to sleeping in a bed and takes satisfaction in neatly covering itself. There is no reason to doubt the fact because it is well established that all of the anthropoid apes appreciate comforts and speedily avail themselves of any

Fig. 34. White-handed gibbon, *H. lar*. Courtesy of New York Zoölogical Society, E. R. Sanborn, photographer.

facilities for increasing their satisfaction in rest or activity which may be provided in their captive environment.

Relative to aquatic locomotion Candler writes:

There is a point about the Hoolock that strikes me as very extraordinary, and that is the fact that he cannot swim. I had been told this by both natives and Europeans, but I confess I was somewhat sceptical about it until I tried experiments myself. We put a full-grown Hoolock into a big tank in 10 feet of water. He struggled helplessly, as a boy would before he learns to swim. He sank twice, with head thrown back and arms waving frantically, and we were obliged to rescue him almost asphyxiated and choking in the most human way.

This weakness he shares with man, but I do not know whether (or not) it has been noted in the other anthropoids.

It is a significant fact that the range of the Hoolock is bounded by two vast rivers, the Brahmaputra on the north and the Irawaddi on the south. It may well be that, with his natural aversion to water, these rivers have confined him to

> the comparatively limited stretch of country he occupies. Travelling high up in the jungle, he could swing easily across the ordinary streams which would come in his path without having to take to the water. The monkeys of India take readily to water, and it is a pretty sight to see them spring out from a lofty overhanging bough and drop, one after another, with a splash into the stream, and strike out boldly for the further bank. (Candler, 1903, pp. 188-189.)

The natural ability of the gibbon to swim has been tested also by Bennett (1834, II, 151-152) with definitely negative results. From the few observations reported it may tentatively be inferred that the animal does not naturally take to the water and is unable to swim.

DIET AND HABITS OF EATING AND DRINKING

It is established that the chief natural foods of the gibbon are vegetable growths. They include various wild fruits, berries, grains, leaves, grasses, shoots, and roots. Some observers state that certain animal foods are also included in the natural diet, as, for example, various insects and other small invertebrates, birds' eggs, and occasionally birds themselves. The dietary information is meager and unsatisfactory, since the evidence is mostly indirect. It is entirely possible that some species or individuals may be exclusively vegetarian, whereas others in varying degree seek animal products.

The diet of captive specimens, although of relatively little naturalistic interest, has practical significance because of varied reasons for maintaining specimens in confinement. It is reported that they readily eat cooked grains, fresh and dried fruits, raw eggs, meal worms, vegetables in great variety either cooked or raw, and in some instances chicken, beef, or other meats in small quantities.

All things considered, we may conclude that they are primarily vegetarians, but that like man they are highly adaptable in their dietary tastes, preferences, and requirements, and may be taught to eat almost anything which is not physiologically injurious. Some captive specimens have been maintained chiefly on a meat diet, but ordinarily a vegetable diet is used on account of convenience and economy. Tickell (1865, p. 198) records the important observation that the young white-handed gibbon, when fed solely on plantains or on milk and rice, is likely to lose its hair, as a result presenting a most ridiculous appearance. Few recover from this condition, but a change of diet, especially enabling the animals to help themselves to insects, in some instances results in the reappearance of the hair.

Our principal sources of information on diet in nature and captivity are the following authors: Bennett (1834), Harlan (1834), Rennie (1838), Martin (1841), Tickell (1865), Schmidt (1886), Blanford (1889-91), Klein, A. (1894), Candler (1903), Elliot (1913), Robinson (1925).

In general, gibbons have the habit of taking water by either sweeping the arm along the moist leaves of forest trees or by dipping the hand and forearm into water and licking the accumulated supply from the fingers, back of the hand, and hair of the wrist. This habit is perfectly natural in view of the facts which have already been presented, for the tree habitat and the long arm of the animal render this method of obtaining water convenient and appropriate. There are undoubtedly species and individual variations in manner of drinking and the reports on the drinking habits of captives vary widely and naturally enough differ in many respects from those based on observations in nature. We have not been able definitely to establish species differences. Hand-drinking, as it may be called, seems to be universal in the gibbon family, but a particular captive specimen may use the hand either as a scoop to take up water or, somewhat as in its wild environment, by dipping and licking off the accumulated drops. Another individual, or perhaps the same one under slightly different conditions, may place its lips to the water and drink directly. Occasionally it has been reported that an individual would

raise the vessel of liquid to its lips and drink in human fashion.

Blanford (1889-91, pp. 7, 9) states that the hoolock drinks with its lips, putting its head down to the water as monkeys do, whereas the white-handed gibbon drinks by scooping up the water in its hand. On the other hand, Pocock (1905, p. 176) states that both the hoolock and the white-handed gibbon habitually drink by dipping the back of the hand and the knuckles into the water and licking it off. Strictly speaking, they do not scoop up the water but merely dip the hand and arm in. The same author describes direct drinking on the part of a Hainan gibbon in captivity. That this was an acquired adaptation is rendered probable by the fact that an injury to the individual's right hand rendered that unusable and that the left hand frequently was used for holding to some object while water was taken.

These various accounts of methods of drinking are peculiarly instructive as indicating dangers of misconception or inadequacy of description when observation is limited to a single captive specimen, and the life experience and conditions in captivity are not fully described. Our consideration of the sum of information leads to the conclusion that the practice of dipping is of primary importance, and that the different authorities have noted variations of this practice or deviations from it which are related to species characteristics and habits and to adaptations to conditions of captivity.

LIFE HISTORY

All observational reports agree in indicating that the several species of gibbon are gregarious, living in groups of varying size. Sometimes undoubtedly these are family groups; again the males, if not also the females, appear to be segregated. But more particular description of gregariousness logically belongs in the chapter on affectivity, and the topic is mentioned here as introductory to consideration of sex and reproduction.

It is significant that the literature contains few references to courtship and mating activities, and almost no definitely established facts. Turpin (1771, p. 309) says that "they [the gibbons] do not offer a scandalous spectacle of unbridled passion." This casual remark indicates a contrast between the behavior of gibbons and that of monkeys and great apes. The utter lack of description of sex activities indicates, we believe, the relative difficulty of observation and suggests that shyness, timidity, or perhaps seasonal mating, may restrict exhibition of sexual behavior. It may be a matter of affective constitution, strength of sex impulse, or reaction to the presence of an observer. But, whatever the reasons, ignorance of the sex life of the gibbon is very nearly complete.

Concerning age, sexual maturity, and the phenomenon of menstruation we cite the following observations.

The occurrence of menstruation in gibbons is attested by Buffon (Barr's translation, 1797, IX, 187) and by Harlan (1834, p. 53). More recently a specimen carefully observed by Pocock furnished exceptionally valuable information. It was received in London in January, 1904, having formerly belonged to Mr. E. H. de St. Croix who had procured her in the Island of Hainan in July, 1897. She, therefore, had been in captivity about six and one-half years. When captured she was thought to be about six weeks old, but within six months she was practically independent. It is assumed that she probably was born in 1897. Pocock (1905, p. 170) arranged for systematic observation of this Hainan gibbon. Menstruation is reported to have begun in December, 1903, when the animal was approximately seven years old and had achieved her growth. Subsequent systematic observation indicated that the interval between menstrual discharges was approximately a month, and that discharge continued for two or three days. Cessation of menstruation occurred for two winter months during which the gibbon suffered from influenza and diarrhea.

Welch (1911, p. 355) likewise reports menstruation and comments thus on its late appearance: "The delayed development of the scrotal bag and diminutive size of the testicles correspond to the late commencement of menstruation. . . . It seems to be the normal course that in *Hylobates* menstruation is delayed until a much later period than is normal in Man."

We may tentatively conclude that the gibbon becomes sexually mature at from five to eight years of age and that menstruation occurs at intervals of approximately thirty days.

On the basis of evidence which we shall exhibit in subsequent paragraphs the period of gestation is supposed to be approximately seven months. As a rule there is a single birth. Of this Tickell (1865, pp. 197-198) writes: "The young seldom reach maturity when deprived of liberty. They are born generally in the early part of the cold weather, a single one at a birth, two being as rare as twins in the human race. The young one sticks to its mother's body for about seven months, and then begins gradually to shift for itself."

Pertinent also are the following statements from Blanford and Forbes: "But a single young is born at a time. Neither the period of gestation nor the age at which these animals become adult appears to have been ascertained." (Blanford, 1889-91, p. 7.) "The female produces but a single young one at a birth, of which she takes the greatest care. She carries it about, clinging to the under side of her body, for many months. It is said that she even takes it to the waterside from time to time, and with much solicitude, and in spite of its cries and resistance, washes its face." (Forbes, 1894, II, 151.) It may here be remarked that the face washing is thought by most authorities to be a misinterpretation of the behavior of the female as with baby clinging to her breast she bends over to dip water from a pool and lick it from her hand. We can readily imagine that the female gibbon, observed at a distance, drinking in its peculiar fashion might appear to be washing its infant.

Little is known of reproduction and the family life of either gibbon or siamang in freedom, and commonly it has been stated that these animals do not breed in captivity. It is our good fortune to be able to present certain rarely interesting observations.

Reynold A. Spaeth, who devoted some months to an intensive study of problems of reproduction in the gibbons of Siam and whose life was sacrificed to the risks of tropical research, left notes on which Mrs. Spaeth has based a most interesting description of "The tree-walkers of the tropics." With her permission we are several times referring to her husband's observations as reported by her, and we here quote a paragraph which is of peculiar value.

> Dr. Spaeth found that the gibbons were for the most part in family groups. So far as he could ascertain, they have their young in the early summer and spring, and almost all the females that he collected were either just going to give birth to a young one or were already suckling this year's baby. On one occasion he came upon a group of males alone in a tree early in the morning, conversing in the typical male gibbon tones, and he concluded that it was some sort of bachelors' club gathering. But as a rule he found what appeared to be families. The gibbon has only one young a year and it takes three or four years for them to mature, so a family frequently consisted of two or more young ones in various stages of growth beside the father and mother. . . . They hang onto the mother with an extraordinarily strong grip as she swings thru the trees. She appears not to be in the least incommoded by the baby hanging to her and swings along as unconcernedly as tho she were alone.

Mrs. Spaeth in her next paragraph reports birth of two gibbons in the "compound" of A. W. Ogilvie, Prae, Siam, and remarks:

> Mr. Ogilvie's gibbon family is the only instance on record of the gibbons breeding in captivity. (From unpublished manuscript, "The Tree-walkers of the Tropics," by Edith E. Taussig Spaeth.)

The facts are thus reported by Ogilvie:

> Records of the Gibbon of Siam (*Hylobates lar*) breeding in captivity, are I believe unknown and

the following instance, although the animals were not in strict captivity, is interesting.

In April 1914 I bought and turned loose in my compound five gibbons, two white and three black. One of the black ones subsequently became savage and had to be shot, but the other four lived amicably together until March 1920 when one of the white ones was noticed to be pregnant and in May gave birth to a young one. A black gibbon who was obviously the father attached himself to her, and the other two were chased from their accustomed trees and never allowed in the compound.

At the time of writing the young gibbon though over two years old and quite big enough to fend for itself still clings to its mother when she moves rapidly from tree to tree, and more remarkable still, is nursed by her and has never been seen to take any of the solid food provided for the other monkeys. (Ogilvie, 1923, p. 137.)

Remarkable in this instance is the prolonged period of nursing and of dependence of infant on mother.

We have discovered authoritative report of two other births in captivity. They occurred in the Rangoon Zoölogical Gardens during 1923 and 1924. In presenting report on these cases Robinson emphasizes the delicacy of the white-handed gibbon and usefully describes the method of housing and caring for these apes in the Rangoon Gardens. Since his brief account of circumstances of mating, birth, and relations of infant to mother is unique, we quote fully:

We find it impossible to leave a male and a female in the same cage. We selected a pair of gibbons that we had had for seven years and which had not been sick during that period. It was reported to the Superintendent that these two had been seen copulating once in the early part of November 1922, and, as the young one was born on the 1st of August 1923, the period of gestation was thought to be about nine months. When the father was let into the outer run for exercise, it was noticed that the mother took her seat close to the expanded metal on the side of the run. The male then clung to the expanded metal opposite her, and copulation was effected through the netting.

In the case of both the young ones born, they were born at night, and the day before the birth the mother refused her food. She seemed dull, restless and frightened. From the appearance of the cage on the following morning, it appeared that the mother must have dragged about the infant until the placenta got broken off. The same was observed on the occasion of the second birth. She kept the baby pressed close to her breast and, from time to time, pulled back its head, gazing at it eagerly and displaying the utmost pleasure in it. She hardly ceased examining it and turning it over

Fig. 35. A baby gibbon in Siam, species undetermined, said to be less than a year old. Courtesy of Mrs. R. A. Spaeth.

and stroking it. She kept it clean with her hands and, for some weeks, would not allow anyone to see it.

The first baby died owing to a catastrophe. The mother and child had been let out into the outer run and, as was perhaps natural, she took the child to the father's cage to show it to him. He took hold of the baby's finger and was fondling it when something apparently frightened the mother, who desired to retire. The father objected and held on to the baby's finger and, between the two parents, the unfortunate infant's finger was pulled off, and it died of septic poisoning on the 12th September 1923.

The parents were observed to copulate between the 15th and 23rd of October 1923, many times, and the second infant was born on the 19th of

May, 1924. This puts the period of gestation at about seven months, and it would appear that it could not have been much longer. Enlargement of the breast, and fullness of the stomach only showed in the mother in the advanced stage of pregnancy. The infant clung on to its mother's hair, but the mother kept her arms round it in the earlier stages, and, whenever she could be induced to leave her retiring stage at the top of the cage, she always supported the infant as she came down with her thigh or her foot. She fed the infant from her breasts, and did not allow it to partake of any other food.

The baby was born with its eyes open; the head and ears were comparatively large. It had a moderate quantity of thick hair on the head, and thin, soft and downy hair on the back. There was little or no hair on the outer aspect of the arms and thighs, while the other parts of the body were quite bare. It was impossible to find out anything about its dentition; but the first gibbon which died within six weeks of its birth had four incisors at the time of its death. After eight weeks the hair has grown very thick and luxuriant on the head; and the back, the outer aspects of the arms, thighs and hands are now also fully covered with thin and soft hair; while the abdomen, the forehead, chest and buttocks are still bare. When born, its face was heavily lined and wrinkled, but in a few weeks the skin has smoothed out; the face is clear and, from looking an old and decrepit object, it now appears young and smooth.

We had kept the outer doors of the cage shut, so that the mother should not be disturbed by visitors, and the only person she saw was the Superintendent, who visited her daily and saw to her food. When it was about four weeks old, I visited it, and, when we opened the doors, the mother and child were on the upper shelter. There were only the Superintendent and myself and a keeper at the back, I called the mother and offered her a mango; she at once came down and seemed to be quite without fear. She knew us all, which may perhaps account for that. It was interesting to note the way she clambered down, supporting the baby at each step, and, when seated at the front of the cage, peeling and eating the mango with one hand, she kept holding out the baby's hand towards us, with the intention probably of teaching it to catch hold of the wire netting. This gave us a very excellent view, and time to record the progress made in the matter of the hair, but we could see no sign of teeth.

We have so far not attempted to take any photographs; indeed, it would be almost impossible, partly because the mother would not come forward with the child, and partly because in the rains in Burma the light is too poor to enable photographs of any value to be taken of animals inside a small cage. It is hoped to be able to do so before long. (Robinson, 1925, pp. 456-458.)

Of the span of life in gibbon and siamang nothing is definitely known. According to Harlan (1834, p. 59), who in turn cites Burrough as his authority, the natives of Assam assert that the gibbon may live to an age of twenty-five or thirty years. In a few instances specimens have lived in zoölogical gardens for fifteen or twenty years.

Although this account of the life history of the gibbon is a mere sketch which lacks completeness and satisfactory verification of fact, we believe that it fairly represents the status of knowledge and we hope that it exhibits extraordinarily important opportunities for naturalistic and experimental observation.

GIBBONS IN CAPTIVITY

Gibbons have the reputation of being very delicate and difficult to keep in European and American zoölogical gardens. There are records of many years' life in captivity, but the average appears to be a few months. We have obtained information from the directors of nearly a score of exhibition parks. One specimen of white-handed gibbon has lived for more than twenty years in the Philadelphia Zoölogical Garden. Undoubtedly the physique, ecological needs, habits of life, and temperament of these apes unfit them for close confinement and a sedentary existence. It is well known that they are peculiarly sensitive to subnormal temperatures and that they succumb readily to exposure to drafts or cold and to inadequate or otherwise unsuitable nourishment. Even their social environment appears to be important for health and contentment.

Most frequently mentioned as causes of death in captivity are respiratory diseases, due doubtless to unreasonable exposure, and intestinal disorders induced by the combination of improper foods and exposure. "The Gibbon is a very delicate animal, in spite of its selecting usually an elevated habitat, and rarely survives long in captivity, generally succumbing to some pulmonary complaint." (Elliot, 1913, III,

150.) And of the hoolock, Candler (1903, p. 187) says: "Owing to its extreme delicacy and the great difficulty experienced in keeping it alive in confinement, it does not often find its way into European collections. Even in the Calcutta Zoölogical Gardens it is difficult to keep Hoolocks alive for any length of time. They often succumb to pneumonia, or if they escape actual disease they mope and die from the effects of confinement, or possibly from deprivation of some article of diet which in the wild state they have been accustomed to." That the animals may be satisfactorily maintained in a semi-wild condition in their native countries is indicated by the statements of Mrs. Spaeth.

But having critically examined all the information available on the constitution of the gibbon and its relations to captivity, we are unable to subscribe to the prevalent opinion that it is peculiarly delicate and incapable of adaptation to new conditions of life. Instead, it seems to us that these exceptionally interesting anthropoids are to a considerable extent the innocent victims of human ignorance, stupidity, and carelessness. Usually we fail lamentably to protect them from infectious diseases, or to cure disorders once contracted. We fail likewise to maintain proper hygienic conditions, a balanced ration, and to provide suitable exercise and adequate social environment. Although unquestionably there are differences in degree of hardiness among the genera, species, and individuals of anthropoid apes, biologically intelligent care, we feel assured, will suffice to maintain almost any normal specimen in healthy and contented captivity for a long time.

CHAPTER SEVEN

AFFECTIVITY AND ITS EXPRESSIONS IN GIBBON

ONE takes pleasure in raising this species of monkey [the 'onke,' Siamese gibbon?] because they are gentler than the others. . . . Economical and dexterous, they never break or smash anything. Friends of peace, and full of compassion, they wish to embrace those who weep, and their pity redoubles in proportion as they hear the groans of the unhappy; they never abandon those whose tears have not dried." Thus speaks the Siamese missionary Tabraca through Turpin (1771, p. 309). It seems to have been settled by this gentle spirit that our primate fellow creatures should be described with sympathetic anthropomorphism. One may respect the sentiment while questioning both the accuracy and the adequacy of the description.

The foregoing chapter has offered glimpses into the affective life of the gibbon. It remains now to attempt a connected and, as nearly as may be, complete description of affective expressions. If it were our responsibility, we should be eager to apologize for meagerness of knowledge, insight, and interest. Evidently in this sphere of psychobiology we know only in part, and it may be suspected that the larger, if not also the better, part of acquaintance with the emotional traits of the gibbon is yet to be achieved. With the scanty information which we have been able to gather from a scattering and barely scientific literature, we shall do our best to indicate facts, informational trends, problems, and opportunities. But our description will necessarily be an indefinite sketch instead of a finished and accurate portrait.

Oftener than any other the word gentle appears in accounts of the temperament and disposition of gibbons. There is perfect agreement among observers that they are shy, timid, wary; good-tempered, affectionate, gentle; readily trained when young, fond of petting or cuddling, and appreciative of human kindness. Exceptions test this rule, and in any particular captive individual, whatever the species, one may happen upon quickness of temper, irritability, and resentment of human attentions. Usually friendly and approachable even by strangers, this slightly built anthropoid is capable of biting savagely and of inflicting serious wounds. Seldom, however, is it the aggressor except under extreme provocation. Nevertheless, it is wise for one who is inexperienced in handling them, or lacking in self-confidence, to await their advances instead of forcing attention. Like the other anthropoid apes they are quick to detect and resent unfriendliness or unkindness, and long remember such experiences. Maltreatment or cruelty from a man may, it appears, make them suspicious of all men, while remaining friendly and trustful of women (Martin, 1841, p. 431). Such conditioned behavior we often misunderstand or misinterpret in ignorance of its history.

Of the hoolock, Burrough, as quoted by Harlan (1834, pp. 57-58), says:

> The individual in question became so tame and manageable in less than a month, that he would take hold of my hand and walk with me, helping himself along at the same time with the other hand applied to the ground as described above. He would come at my call and seat himself in a chair by my side at the breakfast table, and help himself to an egg, or the wing of a chicken from my plate, without endangering any of my table furniture. . . . In temper he was remarkably pacific, and seemed, as I thought, often glad to have an opportunity of testifying his affection and attachment for me. When I visited him in the morning, he would commence a loud and shrill Whoo-whoo-whoo-whoo, which he would keep up often from five to ten minutes, with an occasional intermission for the purpose of taking a full respiration; until finally, apparently quite

exhausted, he would lie down and allow me to comb his head, and brush the long hair on his arms, and seemed delighted with the tickling sensation produced by the brush on his belly and legs.

This description is of special interest because it refers to an adult individual.

It is noteworthy, writes Heck (1922, p. 622), "what an irresponsible tendency gibbons have to allow themselves to be cuddled and petted." Certain, if not all, species and many individuals are extraordinarily gentle, friendly, and eager for human kindnesses.

The siamang differs from the true gibbons no less, it would appear from our imperfect information, in disposition than in structure. Raffles (1822, p. 243) characterizes it as bold and powerful, whereas the other gibbons are timid and gentle. Yet Forbes, an equally reliable authority, devoted to exactitude of description, reports of a young siamang, found clinging to its dead mother and brought in alive, that in a very short time it became a most delightful companion.

Its expression of countenance is most intelligent and often very human; but in captivity it generally wears a sad and dejected aspect, which quite disappears in its excited moods. With what elegance and gentleness it takes with its delicate taper fingers whatever is offered to it! Except for their hairiness, its hands, and, in its youth at all events, its head, seem to me more human than those of any other Ape's. . . . The gentle and caressing way in which it clasps me round the neck with its long arms, laying its head on my chest, and watching my face with its dark brown eyes, uttering a satisfied crooning sound, is most engaging. Although it often inflates its laryngeal sac, it rarely gives utterance to more than a yawn-like noise or suppressed bark; but this dilatation has no reference apparently to its good or bad temper, although, when very eager and impatient for anything, a low pumping bark is uttered. Every evening it makes with me a tour round the village square, with one of its hands on my arm. It is a very curious and ludicrous sight to see it in the erect attitude on its somewhat bandy legs, hurrying along in the most frantic haste, as if to keep its head from outrunning its feet, with its long free arm see-sawing in a most odd way over its head to balance itself, and now and again touching the ground with its finger-tips or its knuckles. (Forbes, 1894, II, 168-169.)

Sharply contrasting with this picture of the siamang is that of Duvaucel, who was at one time employed as naturalistic observer in Sumatra by Sir Thomas Stamford Raffles. The passage which we venture to quote was originally published in E. Geoffroy-Saint-Hilaire and F. Cuvier's *Histoire Naturelle des Mammifères*. It has been often quoted, much discussed, and also adversely criticized.

Servitude, however long, seems to have no influence in modifying the characteristic defects of this ape [the siamang], his stupidity, his sluggishness, and his awkwardness. It is true, that a few days suffice to make him as gentle and contented as he was before wild and distrustful; but, constitutionally timid, he never acquires the familiarity of other apes, and even his submission appears to be rather the result of extreme apathy than of confidence and affection. He is almost equally insensible to good or bad treatment; gratitude and revenge are sentiments alike foreign to these animated machines. All his senses are dull and imperfect; if he regards an object it is manifestly without interest—if he touches it, it is involuntarily. In a word, the siamang exhibits an absence of all intellectual qualities; and if animals were to be classed according to their mental capacities, he would unquestionably occupy a very inferior station. Most commonly squatted on his hams, with his long arms twined round him, and his head concealed between his legs, a position which he also occupies while sleeping, he is seldom roused from his lethargy, nor does he break silence, unless at intervals, to utter a disagreeable cry, which in sound approaches to that of a turkey-cock, but which appears to be expressive of no sentiment, nor to declare any want, and which in fact expresses nothing; hunger itself does not arouse him from his natural apathy: in captivity he receives his food with indifference, carries it to his mouth without avidity, and sees himself deprived of it without testifying either surprise or resentment. (Duvaucel, quoted from E. Geoffroy-Saint-Hilaire and F. Cuvier, 1824, *Le Siamang,* p. 2.)

Because it is at variance with almost all other reports this author's description fails to inspire confidence. Perhaps the most generous way to account for its contradictory nature is to assume that Duvaucel unwittingly observed and perhaps accurately described the behavior of a diseased or otherwise enfeebled and decrepit captive specimen.

In one of the very best early descriptions

Fig. 36. Portrait of a gibbon. Unidentified, but probably *H. hoolock*. Courtesy of G. Krause.

of the behavior of a captive siamang, Bennett (1834, II, 149) thus comments on his subject: On shipboard "he was so docile when at liberty, and so very much irritated at being confined, that he was permitted to range about the deck or rigging." And later this individual is mentioned as grave of look and mild of manner.

EMOTIONAL EXPRESSIONS

Among the many references in which, more or less incidentally, mention is made of affectivity or its expressions in the gibbons, not more than a score are worthy of serious consideration, and even in these there is little well-established or indeed adequately stated information. One may reasonably infer from present evidences that the animals express varied emotional experience. We have attempted to arrange our materials in certain familiar affective categories, and although we recognize their inadequacy we present them as indication of the status of knowledge and to exhibit primary needs and obvious opportunities for research.

Jealousy, resentment, anger, and rage gain varied expression. It is established that the gibbon is likely to resent attention given by its master or mistress to other animals, or indeed other individuals of its species. We have found no mention of jealousy of persons, and we are not able to give from the available literature a worth-while description of the manifestations of what is referred to as jealousy by Schmidt (1886, p. 14), who speaks of the animal's resentment of the care of other nearby animals and the belief that the gibbon may die if another is preferred to it. And for the following, Raffles is authority:

> It is the general belief of the people of the country that it will die of vexation if it sees the

preference given to another; in corroboration of which I may add, that the one in my possession sickened in this situation, and did not recover until relieved from the cause of vexation by his rival the Siamang being removed to another apartment. (Raffles, 1822, p. 243.)

This, by the way, is an inadequately founded belief, applied not only to the gibbon but to the other anthropoid apes.

Undoubtedly there is basis for the statement that agreeable social environment is essential to the normal health and contentment of the animals. Determined resentment of disagreeable treatment is tentatively described by a number of observers. For example, Blyth (1844, p. 465) writes:

I can testify to the capability of these animals to inflict serious injury, from having witnessed a tame female of the Sumatran *H. agilis* suddenly attack her keeper, by springing up at him, grasping his body with her four limbs, and biting at his chest, when it was fortunate for the man that her canines had been previously filed down; in consequence, as was said, of her having occasioned the death of a man at Macao.

And the author adds by way of footnote comment:

From what I have seen of the Gibbon tribe when brought up tame, no animals could be more gentle and good-tempered; but the lady in question had good reason for the utter hatred which she bore to her keeper, who used to make her display her wondrous activity a hundred times a day, in swinging from bough to bough of a large artificial tree by means of her fore-limbs only, by frequent application of the whip.

Anger and rage in these creatures, as in children, are readily evoked and gain free expression. Like the child, they quickly recover from emotional outbursts and there is evidence that the behavior is expected to achieve some desired end. Bennett has given a description of anger in the Ungka ape (siamang) which is confirmed and in certain directions supplemented by that of Tickell for the white-handed gibbon.

At sunset, when he was desirous of retiring to rest, he would approach his friends, uttering his peculiar chirping note, a beseeching sound, begging to be taken into their arms; his request once acceded to, he was as adhesive as Sinbad's old man of the sea; any attempt to remove him being followed by violent screams. He could not endure disappointment, and, like the human species, was always better pleased when he had his own way; when refused or disappointed at anything, he would display the freaks of temper of a spoiled child; lie on the deck, roll about, throw his arms and legs in various attitudes and directions, dash everything aside that might be within his reach, walk hurriedly, repeat the same scene over and over again, and utter the guttural notes of *ra, ra;* the employment of coercive measures during the paroxysms reduced him in a short period to a system of obedience, and the violence of his temper by such means became in some degree checked. Often has he reminded me of that pest to society, a spoiled child, who may justly be defined as papa's pride, mamma's darling, the visitor's terror, and an annoyance to all the living animals, men and maid-servants, dogs, cats. . . . (Bennett, 1834, II, 152-153.)

Anger it shows by a fixed steady look, with the mouth held open and the lips occasionally retracted to show the canines, with which it can bite severely, but it more usually strikes with its long hands, which are at such times held dangling, and shaken in a ridiculous manner, like a person who has suddenly burnt his fingers. (Tickell, 1865, p. 197.)

One finds also references to the animals throwing themselves on the ground, flinging themselves about, and screaming loudly, when they are disappointed or provoked.

Of the physiological concomitants of anger or rage the literature gives no information.

It is entirely evident, even from available imperfect descriptions, that timidity, fear, and terror are intimately related to resentment, anger, and rage, and that the former emotional and expressive condition may almost instantly give place to the latter. Thus, for example, the anthropoid ape who is alarmed or actually frightened by an unfamiliar object or by the menacing behavior of another animal may become aggressive and vigorously express resentment or anger the moment the fear-inspiring object begins to retreat or withdraw.

There are no quotable examples of the replacement of timidity by resentment, but we have often observed it ourselves in each type of anthropoid ape, and it is well known in man. Although it is repeatedly stated that gibbons are timid, there is a dearth of descriptive material on fear and

Fig. 37. A gibbon expresses interest and surprise. Courtesy of G. Krause.

terror. All that the literature actually supplies is a few instances of fear-evoking situations. Thus Forbes, of his own knowledge, tells of the unexpected terror and inhibition of action in a group of siamangs which became isolated in some trees that were being felled:

That they can leap the great distances from tree to tree ascribed to them is no doubt an accurate observation; but they appear to be sometimes terror-stricken and unable to perform these feats to save their lives. During the felling of the forest near this village, a small colony of Siamangs got isolated on a tree separated from the next clump by some thirty feet or so. They scampered up and down in the crown of the tree howling in the most abject terror at every stroke of the axe; yet they would not venture to leap the intervening space, and even, when the tree was falling, they did not attempt to save themselves by springing to the ground, but perished in its downfall. (Forbes, 1894, II, 169.)

According to Mitchell snakes disturb gibbons much less than they do the great apes.

Tried with various kinds of snakes,

the gibbons were least timid; a very small agile gibbon showed no fear and very little curiosity, while a full-grown example of the same species and a hoolock gibbon showed no panic, but retreated very decidedly. It is possible that gibbons, as they are the most agile and completely arboreal of all the monkeys, run little risk from snakes and have partly lost their fear. (P. Chalmers Mitchell, 1912, p. 201.)

Of the emotional categories suggested by aversion, disgust, shame, and modesty, we have found no noteworthy mention in the literature on the gibbon. This is of interest

Fig. 38. Expression of fear in a gibbon. Courtesy of G. Krause.

primarily as informational lack which doubtless can readily be remedied by the determined observer, and secondarily as indicating possible contrast between the gibbon and the other anthropoid apes with respect to the existence or frequency of expression of these modes of feeling.

Grief and sadness are occasionally referred to with the usual brevity and inadequacy of description. The following is Forbes's account of the death of a gibbon:

The Wau-Wau has a wonderfully human look in its eyes; and it was with great distress that the writer witnessed the death of the only one he ever shot. Falling on its back with a thud on the ground, it raised itself on its elbows, passed its long taper fingers over the wound, gave a woeful look at them and at his slayer, then fell back at full length—dead—"saperti orang" (just like a man), as his Malay companion remarked. He kept in captivity for a short time a specimen which was brought to him by a native, and it became one of the most gentle and engaging creatures possible; but when the calling of its free mates reached its prison house, it used most pathetically to place its ear close to the bars of its cage and listen with such intense and eager wistfulness that it was impossible to retain it in durance any longer. It was accordingly set free on the margin of its old forest home. Strange to say, its former companions, perceiving perhaps the odour of captivity about it, seemed to distrust its respectability, and refused to allow it to mingle with them. Amid the free woods we may hope that this taint was soon lost and that it recovered all its pristine happiness. (Forbes, 1894, II, 156-157.)

Amusement, delight, and joy likewise are seldom mentioned and never adequately described in the literature. Yet their existence in the gibbon cannot be doubted. Repeatedly reference is made to the playfulness of the young and to their evident satisfaction in amusing themselves by simple

games which are played either with others of their kind or with human companions. Occasionally there are found references to attempts on the part of these creatures to express appreciation of human friendliness or kindness.

Affection and sympathy for one another and for persons are more frequently mentioned in the literature than any other types of emotional expression. From an anonymous writer we quote the following paragraphs descriptive of intraspecies sympathetic relations, and at the same time typical of the information offered by various authorities.

> Having read the letters of Dr. Gulliver and G.J.R. in *Nature,* Vol. VIII, pp. 103 and 163, in which the affection of monkeys for their dead is discussed, I think that I may perhaps be permitted to record my experience in regard to a certain class of monkeys that I have peculiar facilities for observing, which is not in accordance with the observation of Mr. Forbes or G.J.R.
>
> I keep, in my garden, a number of Gibbon apes (*Hylobates agilis*); they live quite free from all restraint in the trees, merely coming when called to be fed. One of these, a young male, on one occasion fell from a tree and dislocated its wrist; it received the greatest attention from the others, especially from an old female, who, however, was no relation; she used, before eating her own plantains, to take up the first that were offered to her every day and give them to the cripple, who was living in the eaves of a wooden house; and I have frequently noticed that a cry of fright, pain, or distress from one would bring all the others at once to the complainer, and they would then condole with him and fold him in their arms.
>
> But one morning one of the flock was found hanging dead in the fork of a tree, his comrades took no notice whatever of him, and were playing and singing their peculiar song as usual close to him; on the body being removed they took no notice whatever.
>
> A neighbor of mine who keeps a pair of these apes, informs me that the male lately came home after an absence of two days very sick; the female, who had theretofore been very affectionate, carefully avoided him, and on his death a few days after showed the most thorough indifference. Very possibly the alleged affection for their dead may exist among some families of monkeys, and not among others. Though my apes live in complete freedom, they have never shown any disposition to breed, though I have had some of them over two and a half years. (Anonymous, Æ, 1874, p. 243.)

Referring, it is thought, to one species of gibbon, sympathetic expression is thus described:

> These animals were reserved, very gentle, and uncommonly cleanly as to their bodies and their food. They evinced great attachment for each other, as particularly appeared during the sickness of the female; the other holding her in his arms as a parent does her infant! and after her death he immediately refused sustenance, and, as before stated, shortly died. (Lewis, 1834, p. 33.)

From varied experience as hunter and superintendent of zoölogical park, Hornaday offers the following:

> With the *Gray Gibbon,* of Borneo, I am well acquainted; and after the three great man-like apes, it is to me the most wonderful of anthropoids. They are very timid, the shyest of all Primates that I ever hunted, and wonderfully successful in eluding the hunter. Nevertheless, so strong is their affection for their young, I have seen a whole troop that had made good its escape, return at the call of an infant Gibbon in trouble, and all reckless of their own safety come down within twenty feet of their deadly enemy. Very few other mammals will do this. (Hornaday, 1904, p. 12.)

Attachment to persons is a matter of frequent record and there are several instances of special expressions of affection or sympathy which involve aggression on the part of the gibbon, as, for instance, in attempting to defend a human friend or companion. On the other hand, it is stated that in the flight of a troop, the mother gibbon sometimes abandons her young and again protects and defends it at the risk of her own life. Although the fact is not clearly established in the literature it may well be that such markedly different behavior is related rather to the nature of the situation in which the animal finds itself than to individuality or species.

SOCIAL RELATIONS

As already remarked, all of the species of Hylobates and Symphalangus are known to be gregarious, but the social relations and habits of species differ somewhat.

On the authority of Duvaucel, Martin says that the siamang is gregarious, and

Fig. 39. Friendliness expressed by a gibbon. Courtesy of G. Krause.

that each troop has a chief believed by the Malays to be invulnerable. The Ungka-puti (agile gibbon) is said to live in isolated couples (1841, p. 419). This is confirmed by Forbes (II, 153) who says it is found generally in small troops or in pairs. According to Tickell (1865, p. 196), the white-handed gibbon lives in bands of

eight to twenty individuals, although occasionally a solitary male is met with. The largest assemblages are those of the hoolock which are described by Blanford (1889-91, p. 6) as found associating in flocks of fifty to one hundred individuals, or even more. He also refers to the occasional solitary male. Only in the case of the siamang is the chief or leader especially mentioned, and in that case by only two authorities, Duvaucel and Broderip (1849, p. 244).

With reference to the coöperative relations of gibbons, next to nothing seems to be known. Some observers assert that troops, however large, will abandon a wounded comrade, and instances are reported of seemingly sympathetic coöperative action. It appears that the latter, and perhaps exceptional action, is more often observed in captive individuals than in nature, possibly because they are more accustomed to men and less dismayed by their presence or threats when there is occasion for sympathetic action. Nowhere have we discovered even the suggestion that any species regularly constructs anything in the nature of a shelter from the rain or the cold. It seems improbable that animals should live in bands as do the gibbons without developing a considerable measure of helpful coöperation. But obviously the subject is more appropriate for field study than for speculative consideration.

Naturally there are more accounts of relations with human beings than with members of the species, and especially of friendships and playful activities. One of the most illuminating of these descriptions is that of Bennett, from whom we quote concerning the relations of his gibbon with a Papuan child.

> He was playful, but preferred children to adults. He became particularly attached to a little Papuan child (Elau, a native of Erromanga, one of the New Hebrides group,) who was on board, and whom it is not improbable he may have in some degree considered as having an affinity to his species. They were often seen sitting near the capstan, the animal with his long arm round her neck, lovingly eating biscuit together. She would lead him about by his long arms, like an elder leading a younger child: and it was the height of the grotesque to witness him running round the capstan, pursued by, or pursuing, the child. He would waddle along, in the erect posture, at a rapid pace, sometimes aiding himself by his knuckles; but when fatigued, he would spring aside, seize hold of the first rope he came to, and, ascending a short distance, regard himself as safe from pursuit.
>
> In a playful manner he would roll on deck with the child, as if in a mock combat, pushing with his feet, (in which action he possessed great muscular power,) entwining his long arms around her, and pretending to bite; or, seizing a rope, he would swing towards her, and, when efforts were made to seize him, would elude the grasp by swinging away; or he would, by way of changing the plan of attack, drop suddenly on her from the ropes aloft, and then engage in various playful antics. He would play in a similar manner with adults; but finding them usually too strong and rough for him, he preferred children, giving up his games with them, if any adults joined in the sports at the same time.
>
> If, however, an attempt was made by the child to play with him, when he had no inclination, or after he had sustained some disappointment, he usually made a slight impression with his teeth on her arm, just sufficient to act as a warning, or a sharp hint, that no liberties were to be taken with his person; or, as the child would say, "Ungka no like play now." Not unfrequently, a string being tied to his leg, the child would amuse herself by dragging the patient animal about the deck: this he would good-naturedly bear for some time, thinking, perhaps, it amused his little playmate; but finding it last longer than he expected, he became tired of that fun, in which he had no share, except in being the sufferer; he would then make endeavours to disengage himself and retire. If he found his efforts fruitless, he would quietly walk up to the child, make an impression with his teeth, in a ratio of hardness according to his treatment: that hint soon terminated the sport, and procured him his liberty. (Bennett, 1834, II, 158-160.)

It has been remarked by various authorities that some at least of the gibbons tend to be more reserved toward men than toward women, and in some instances to exhibit very marked preferences. This obviously may be due on the one hand to the treatment received by the animal from persons, or, on the other, to sex interest. We have observed the latter in a mature female wau-wau.

Entirely characteristic of the anthropoid

apes, according to our experience and our acquaintance with the literature, is the following intelligently appreciative behavior of a young gibbon toward his human caretaker.

When teething my companion suffered severely—as the human infant so often does—both locally and constitutionally, as indicated by boils and inflamed finger-tips. On lancing and poulticing the latter, and extracting some of its obstructing teeth, the poor creature seemed greatly relieved, and I was delighted to watch it recover, without contracting for me any antipathy for the pain I had inflicted on it, but rather the reverse. (Forbes, 1894, II, 169.)

On the authority of the late Doctor Spaeth we have already reported that the gibbons of Siam seem for the most part to live in family groups. This observer discovered that he could distinguish the sexes of the species in point by differences in their calls. On this basis he identified certain social groups as made up of males alone and certain others as mixed or family groups. Again we quote from Mrs. Spaeth to illustrate various points in the affective life and social relations of the gibbon family:

It is practically impossible to capture an adult gibbon alive, unless it can be made to come onto the ground. Swift and sure as they are in the trees, they are singularly awkward and helpless when they have to walk. Their legs are much shorter than the arms and, while they can grip branches and support their weight on their legs easily enough, their legs do not seem well adapted to walking. Frequently they help themselves along with their hands in an ungainly fashion. Once driven out of the trees, they can easily be captured. But most of the tame gibbons are taken as babies, the mother killed and the baby saved. There are instances of a hunted mother gibbon dashing her baby down and so killing it, possibly because she feared its capture but more likely because she found its weight too heavy in her efforts to escape. The baby gibbons, or "chenees" as the Siamese call them, make fascinating pets. They are most affectionate and intelligent little things, soft and furry with bright eyes and clinging arms. Lacking the mother to cling to, they quickly adopt master or mistress in her place and they appear to be perfectly happy travelling about house or compound clinging tightly to a skirt or a trouser leg. Even the older ones will jump readily into the owner's arms, twine their arms around his neck, and make an affectionate little sound like "Hu, Hu." There are hundreds of tame chenees in Bangkok and the Siamese grow very fond of them. They do not train them or use them for any purpose but apparently regard them as members of the family and they will almost never consent to sell them.

The gibbon is far too mischievous and inquiring in temperament to be allowed to run free. They are not kept in cages but fastened by a collar and ring to a chain that permits them to dash about on a high bamboo pole or verandah railing or tree. They are incessantly active and it is extremely difficult to photograph them—they twist and turn and leap about and, if you venture too close, they love to spring on your head, twine their arms about you and give you a quick little bite and leap away again. Except for occasional older animals, disillusioned and teased and jealous, they are generally friendly, but their sense of humor is of the slapstick variety and their little jokes are most disconcerting to a stranger. Before you know what has happened, they have nipped you here and there, thrown your hat into a klong and are back in the tree sampling the contents of your bag, and generally hurling each inedible article after the hat. One of the most entertaining sights is a dog and a chenee playing together. They look as tho they were fighting furiously but it is a toss-up which is enjoying it more. Near our house in Bangkok is a white gibbon about four years old whose particular friend is a coal black dog. When the chenee is turned loose the two roll each other over and chase each other all up and down the house and thru the compound. If the dog nips the ape, the latter springs up on his bamboo pole out of reach but presently he leans down and grabs the dog firmly by the tail, indicating that he is ready to play again. A lady in Bangkok tells me that she had a little black gibbon but she had to get rid of it because it *would* steal into her little boy's room when he was having his nap and tweak the child's nose. He did not hurt him but the child would wake up angrily and try to explain what was happening, while the gibbon sat demurely in a corner. At last, one day, the mother happened to catch him in the act. (From Mrs. Spaeth's unpublished manuscript.)

The subject of social relations, in certain of its aspects, will be continued in the next section, inasmuch as vocalization is primarily a social and emotional expression.

THE VOICE OF THE GIBBON AND ITS USES

The voice of the gibbon has remarkable range and carrying power. Perhaps chiefly because of this fact, vocalization has attracted the attention of naturalists, physi-

ologists, and anatomists, and, in general, the information available is more abundant and also more reliable and self-consistent than that on any other topic of the psychobiology of the animal. Extraordinary characteristics of vocalization early aroused speculation as to the nature of the vocal mechanism, and this curiosity was augmented by the existence of a conspicuous laryngeal sac in the siamangs. Although early descriptions of the voice and its mechanism are of relatively little scientific importance, one or two are worthy of quotation as indicating the nature of interest and the direction of inquiry.

Bennett, in speaking of the neck pouch of the siamang, observes that it has been the subject of much speculation and is thought to be an appendage to the vocal organs. He then continues with report of his own observations:

> For often when irritated, I have observed him inflate the pouch, uttering at the same time a hollow barking noise. . . . The inflation of the pouch was not, however, confined to anger; for when pleased he would purse the mouth, drive the air with an audible noise into the sac; when yawning, it was also inflated; and in all instances, (except when excited by anger,) he would gradually empty the sac, as if he derived a pleasure from it. When the sac has been distended, I have often pressed on it, and forced the air contained within it into the mouth, the animal not evincing at the time any sign of its being an annoyance to him. When uttering the barking noise, the pouch is not inflated to the same extent as when he yawns. . . .

To test the suggestion advanced by certain observers that the laryngeal sac is useful to the gibbon in swimming, Bennett one day placed his subject in a large tub of water. It was, as he reports, much frightened in this situation and "soon began to display a marked hydrophobic symptom, but not the least attempt was made to inflate the pouch, although he was frequently submersed." (Bennett, 1834, II, 150-152.)

The mechanism of vocalization is mentioned also by Candler:

> As in other species of apes, there is a special modification of the larynx, which acts as a sort of resonating-box, and helps (I suppose) to make the sound carry, as it does, long distances. There is also a peculiar arrangement of the upper aperture of the larynx, with its small and inadequate looking epiglottis, which more resembles the arrangement in birds than the leaf-like epiglottis in man. (Candler, 1903, p. 188.)

Attacking the problem of mechanism with the interest and technique of the morphologist, Giacomini examined the vocal structures of the gibbon with resulting excellent description of the larynx. This author states that the order of decreasing resemblance of the structure of the larynx to that of the Caucasian, according to his own observations, is as follows: White male, Negro female, Bosch male, Chimpanzee, Gibbon, Macacus, Cercopithecus, Gorilla, and Orang-outan (Giacomini, 1897, p. 117).

More recently Mott has dissected the larynx of the siamang and by aid of both horizontal and vertical serial sections sought to get such knowledge of its conformation and relations as is necessary for an understanding of vocalization. Omitting his excellent anatomical description, we quote with reference to relations of sound production to characteristic features of anatomy.

> The loudness of sounds is increased proportionally to the amplitude of vibrations of the vocal cords, which is dependent upon the force with which the air is expelled through the chink of the glottis. The animal can by filling its laryngeal sacs bring into play the false vocal cords, which by their approximation necessitates a still further increase of propulsive force before the air can escape and set in vibration the vocal cords—in fact, the animal, when it wishes to emit a loud sound, can employ the "coup de glotte" of the singer. This "glottic shock" is produced by two muscular folds called the ventricular bands, or false vocal cords, which in conjunction with some other muscles cause a complete constriction of the air-passage above the true vocal cords. Their function is to protect the larynx during swallowing and to take any strain exerted by the respiratory muscles during effort, such as *vigorous action of the arms* or abdominal muscles involving the fixation of the chest. Thus action in coughing is of the nature of a spasm preceding an explosion of the breath. . . . Such powers of emitting a loud vocal call of warning or of sexual attraction must play an important part in the self-preservation and preservation of the species of these timid, agile, arbo-

real animals. Doubtless, when this particular Gibbon imitated the low-pitched bark of the dog he employed the whole of the vocal cord, but how did he imitate the shrill whistles of the guinea-pig? In order to imitate the shrill whistles of the guinea-pig it may be assumed that the animal employed some means of considerably shortening the vocal cords and permitting only their free edge to vibrate, as in the human high soprano or falsetto voice in the male. (Mott, 1924, p. 1168.)

Aside from the light thrown on the functional significance of larynx and laryngeal sac by such investigators as Giacomini and Mott, as psychobiologists we are interested in the implication that Mott's siamang imitated the bark of the dog and the shrill squeaks of the guinea pig.

In general, the voice of the gibbon is shrill, penetrating, and in many instances musical. There are times, however, when to a human observer it is extremely disagreeable. Mott (p. 1169) remarks: "The power of variations in pitch, which the Gibbon possesses, may be a means of emotional intercommunication which the other anthropoids do not possess to the same degree." And referring especially to the possible significance of the laryngeal sac, Forbes (1894, II, 151) says that the voice of the gibbon "is very powerful and can be heard at a great distance, especially when they are howling in chorus. The Wau-Wau and the Siamang, the one without, and the other with, a laryngeal sac, are equally vigorous in this respect." The testimony of Blyth (1875, p. 4) is confirmatory of our general description, for he remarks: "They are further remarkable for their exceedingly loud shouting cries, not unmusical in tone, which are often uttered in concert, and differ more or less in the different species." So also is that of Welch (1911, p. 357).

Of curious interest is Shelford's reference to the nature of the gibbon cry and the possibilities of imitating it.

The Gibbons go about in large herds; their cry is extremely musical, and in the early morning the jungle fairly rings with it. I know no more joyous sound in nature than the delightful bubbling shouts of these creatures. . . . The Malay and Kayan names for the Gibbon—Wa-wa and Wok—are onomatopœic in that they represent two notes of the series of whistles and hoots that the animals utter. . . . I know of no instrument on which the cry can be well imitated except a simple thing made by the Kayans out of a bamboo-joint and known as Buloh Wok; with this the cries can be imitated with such great exactitude that the apes are often decoyed within a few yards of the performer. (Shelford, 1916, p. 6.)

Undoubtedly vocalization differs significantly in the species of the family Hylobatidae, not only in accordance with the presence or absence of a laryngeal sac, but also in correspondence with variations in laryngeal structure and the use of the organs. Doctor Spaeth's observation that he could distinguish the sexes in certain species of Siamese gibbon by the voice is pertinent. Whereas heretofore we have found it either impossible or obviously unprofitable to attempt specific descriptions, the observational data on vocalization are reasonably adequate for this purpose.

For the agile gibbon, Martin, with the assistance of Waterhouse, offers the following admirable description:

The voice of this Gibbon is extraordinary, not only for its power and volume, but for the succession of graduated tones in which its cry is uttered. In a room, it is overpowering and deafening: it consists of a repetition of the syllables oo-ah, oo-ah, at first distinctly repeated, and ascending in the scale, but at last ending in a shake, consisting of a quick vibratory series of descending notes, during which the whole of the animal's frame quivers with the effort to produce them: after this, she appears to be greatly excited, and violently shakes the netting or the branch to which she may be clinging; which action being finished, she again traverses her cage, uttering the preliminary syllables oo-ah, oo-ah, till the shake again concludes the series. It is principally in the morning that the animal thus exerts this modulated cry, which is, probably, its natural call to its mate, and which, from its strength, is well calculated for resounding through the vast forests. The following observations on the voice of this animal were obligingly presented to the Author, by Mr. Waterhouse:—

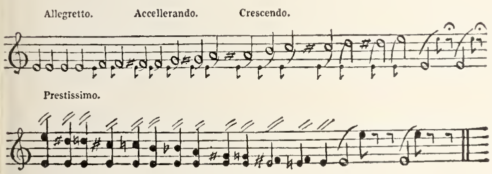
"I should endeavour to give an idea of the whooping of the Gibbon (as far as the music is concerned, but not as regards the quality of sound), by comparing it to the tuning of a harp; first beginning with an E string, and repeating it at short intervals; then being altogether silent for a little time, and then beginning again; next, two

strings, as it were, are struck, E and E sharp (or F natural): the second string is then screwed up, by half-notes, until it reaches the octave; the E and F natural, E and F sharp, E and G natural, &c., being struck nearly together. It must be observed, that, before the upper note arrives at the octave, the animal amuses herself by occasionally descending a few semitones, then ascending again, and so on. But when the octave is once gained, and has been sounded a few times, we may imagine the upper string to be very rapidly let down by semitones; the lower note remaining the same as at first, and the two strings being always struck together.[1] The rapidity of the descending passage is equal to that of an extremely brilliant shake. The animal then remains quiet for a short time; after which follow two barks, each composed of the low and high E, sounded nearly together.

"It appeared to me that, in ascending and descending the scale, the intervals were always exactly half-tones; and I am sure that the highest note was the exact octave to the lowest. In this passage the lips were engaged, and rapidly vibrated during its execution.

"The quality of the notes is very musical; and I do not doubt that a good violinist would be able to give a correct idea of the Gibbon's composition, excepting as regards its loudness. The Gibbon's voice is, certainly, much more powerful than that of any singer I ever heard.

"One more fact I noticed, viz., that the Gibbon is usually a long time before she comes to the rapidly-descending passage; but when she has given it once, she soon runs through the preliminary part of her composition, and again comes to the descending passage." (Martin, 1841, pp. 431-432.)



This description in musical terms is supplemented by report of Welch who says that in addition to the common chatter of excitement and laughter which all species of Hylobates make, the agile gibbon has a loud cry.

[1] "It appears, all through this rapid chromatic passage, as if the animal emitted two notes at a time, as in the music; but this is the effect of the rapid transition from the lower note to the upper."

This peculiar cry of *H. agilis* is best described by a word "whopp," and is shouted out, the mouth being wide open and the throat conspicuously dilated. It is only uttered once and then silence ensues for about thirty seconds, then another "whopp," then a period of silence, then another "whopp," and so on. Usually this cry continues for about ten minutes, but a few times I have heard it continued for over an hour; and very occasionally the "whopp" is prolonged into a long loud screech lasting a minute or longer, the mouth being kept wide open the whole length of the screech and the throat dilated. I have never heard it uttered when playing or quarrelling with the *H. hainanus* (both species utter the common chatter at these times), but only when the *H. agilis* is swinging by itself. It is also a quite different sound from anything uttered by *S. syndactylus*. (Welch, 1911, p. 357.)

Of the nature of vocalization in the Bornean gibbon we have discovered only casual mention. One of the most interesting of the references is that of Elliot, who states that in this species, and in the wauwau also, a peculiar bubbling noise is produced (1913, III, 173).

Pocock, contrasting the vocal expressions of the Hainan gibbon with that of the hoolock, writes:

The voice of our Hainan Gibbon is quite different from that of the Hoolock. It is a high-pitched trill all on the same note, and shriller even than the high note of the Hoolock's cry. It consists of from about three to six distinct cries repeated in very rapid succession, suggesting almost production by vibration of the tongue, although, as a matter of fact, I believe the lips alone are instrumental in producing the effect. There is then a momentary pause, after which the cry is repeated. It may perhaps be represented in the following way:—ho͝o ho͝o ho͝o ho͝o—ho͝o ho͝o ho͝o—ho͝o ho͝o ho͝o ho͝o ho͝o—&c. The Hoolock, on the contrary, cries as follows:—hāh, hōō, hāh, hōō, hāh, hāh, hōō, hāh. The "hōō" is on a lower note than the "hāh," with which the cry frequently ends.

The ordinary expression of anger or remonstrance in the Hainan Gibbon is a prolonged and guttural grunt, which is repeated rapidly and often, and frequently interspersed with a kind of warble when the excitement rises. (Pocock, 1905, p. 176.)

Previously in our account of habitat and habits of life we have quoted Anderson's description of the call of troops of hoolocks as in the morning they ascend the

mountain sides from their sleeping grounds in the valleys (p. 53).

The cry of the Hoolock is a characteristic sound in the Cachar jungle. It is a very pleasing note, rising and falling in intensity, and reminding one somewhat in its rhythm of a pack of beagles giving tongue on a scent which is waxing and waning in strength, as a larger or smaller number of the band join in the chorus. It is heard chiefly in the early morning, then all through the heat of the day there is silence, but towards evening, as the sun sinks, you may hear it again. Hooloo! Hooloo! Hooloo! with the accent on the Hoo syllable, is supposed to describe the sound, but it is really quite indescribable in writing. (Candler, 1903, p. 188.)

Heck, seemingly reporting original observations, writes:

A Hoolock which I saw living in the London Zoological Park for some time, willingly used its voice and at every time of day, as soon as it was spoken to by the keeper or was excited by anyone through imitation of its sounds. I dare say that I have never heard the voice of a mammal, man excepted, which sounded to me more full-toned and pleasanter than that of this gibbon. At first I was astonished, later charmed, by these tones coming from the depths of the chest, drawn out to the fullest power and yet not at all unpleasant. They may be represented by the syllables hu, hu, hu. Other species emit a much less pleasant call. (Heck, 1922, p. 619.)

Referring presumably, although of this we cannot be absolutely certain, to the Siamese gibbon, Mrs. Spaeth offers this interesting description:

They are very noisy animals, with a shrill, mournful, penetrating call. Here in the suburbs of Bangkok we can hear them calling to each other from compound to compound as much as a quarter of a mile away, especially early in the morning. The native children love to imitate them and the apes respond and whoop wildly when the children give their call. To the Siamese the gibbons' cry may sound like "Pua, Pua" but to the European it is more like "Wup, wup, wu-u-u" going up in the scale and gathering volume and shrillness until it ends in a very high trill. Dr. Spaeth described the initial "wup, wup" as "pumping sounds," as tho the animal were gathering steam for the final trill. The males, he said, made more of the pumping sounds and ended with a shorter trill than the females. As he wished particularly to collect females, he found it very convenient to be able to distinguish the sexes by the call. He found that the males called more frequently in the early hours of the dawn, from six to eight. From eight to nine the females took up the cry, interrupted or answered from time to time by the males, and after nine o'clock the gibbons were quiet until late in the afternoon, when they called again but not so persistently as in the morning.

Although we have found several earlier references to the cry of the wau-wau than that of Forbes, they are relatively unimportant, and we, therefore, introduce the subject with a quotation from Forbes:

The Wau-Wau—the Malay name for this Gibbon—is one of the first of the Quadrumana that makes its presence known to the traveller in Java, when he reaches its upland forest regions. In the evening, just about sundown, and more especially in the early morning commencing before sunrise and finally ceasing when the sun is above the tops of the trees, he will be surprised by a sudden outbreak of what appears to be now the loud plaintive wailings of a crowd of women, now the united howling of a band of castigated children. The present writer's first acquaintance with this charming genus of Monkeys was made among the Kosala hills in Western Java, and it will ever remain with him as one of many most pleasant recollections of a long tropical sojourn. Their "woo-oo-ut—woo-ut—woo-oo-ut—wut-wut-wut—wŭt-wŭt-wŭt," always more dolorous on a dull heavy morning previous to rain, is just such a cry as one might expect from the sorrowful countenance so characteristic of the species of *Hylobates*. (Forbes, 1894, II, 156.)

We have noted above (p. 75) the bubbling sound produced, according to Elliot, by both the wau-wau (*Hylobates leuciscus*) and the Bornean gibbon (*Hylobates mülleri* or *concolor*).

From Heck we quote the following borrowed characterization of the wau-wau cry.

The Wau wau begins, as Hasskarl tells me, with a few separate sounds: ua, uua, ua, ua. Then follows more quickly ua, ua, ua; then: ua, uua, ua, ua. And at last a call becoming plain and more rapid, the u shorter, so that it almost sounds like a w, but the a longer, and the whole company never fails to join in with like calls. In the same way sing four silver gibbons which recently came into the Breslau Zoological Park. The largest begins a short ringing sound which becomes louder and louder. The others fall in, the cry becomes strong, so that one could hear it all around in a circle, and it goes over into a rising

scale of twittering sounds which reminds one of a bird, and the whole bodies of the animals tremble. (Heck, 1922, p. 619.)

Our own observation of the characteristic vocalization of the wau-wau agrees closely with Heck's description, but there are many variations of the cry and also other sounds produced by this species of gibbon which should receive scientific attention.

For the white-cheeked gibbon, Boutan, as the result of observation of the species in nature and the study over a period of five years of a female kept in captivity, gives the most elaborate and thoroughgoing account of vocal expressions which is available for any species. This author was interested primarily in the problem of language. Incidentally he noted and carefully described the various forms and phases of vocal expression. The description is lengthy and of quite unusual value. We shall endeavor to report its facts completely and to summarize the main conclusions.

The white-cheeked gibbon (*H. leucogenys*) possesses a voice of great compass. Owen (1868) is quoted by Boutan as stating that the larynx in the gibbon is relatively large and the vocal cords well defined with ventricle intermediately deep and continued into a sac in the thyrohyoid space. The creature is capable of producing a great number of notes and it only "among mammals can pretend to sing." In the wau-wau the scale ascends and descends by half-tones through an entire octave. With the aid of phonographic records, Boutan studied vocal reactions, but he found it difficult to translate the sounds into letters, and he definitely states that the following words merely approximate the vocalizations.

1. State of satisfaction or well-being.

Hôc, hôoc, hôuc—general cry, when food presented or known person or animal in sight.

Hoc, houg, houg; Hag, couag, gouaggac—cry of moderate satisfaction, used chiefly when eating.

Couiiiii (very pointed and repeated often)—cry of great satisfaction, food particularly delicate or not tasted for long time.

Hem-hem (a cough and a heave, expressing effort)—frequently when animal jumps from branch to branch.

Kouhi-hig-hiig (with raising of lips and laugh of mouth)—great evidence of affection—tender salutations.

2. State of illness or fear.

Hôug, houc, oug, houc (mezzo voice)—ennui.

Koc, kog-koug . . . hiiig (with manifestation of anger)—frank hostility. In presence of person displeasing or an enemy; often followed by song of excitation.

Ook-okoug (grave and jerky)—danger, something frightening or unknown; looking at dark corner in evening; seeing object or animal unknown.

Crug-cruuug (peculiar sound accomplished by grinding of teeth)—rare, incomprehensible. Ennui of solitude. Illness.

3. Intermediate state.

Thwiiwwg (sweet and plaintive)—to call attention of friendly person. "I am here."

Ho o o ouguoug (plaintive and long)—salute to beloved person not seen for long. Tempted to interpret as a plaint or friendly reproach.

Kuhig – – – ouk—satisfaction after a play, or a pleasantry which goes too far.

Preut, Pruùt (with vibration of lips)—menace of play. (Only in young animals.)

4. State of great excitement.

Great song of excitement, with roulade and trembling of lower jaw. Heard at great distances in wilds. Mentioned by Owen. (Always preceded by jumping and shaking. May last several minutes.) (Boutan, 1913, pp. 31-33.)

The author observes that no vocal expression for a state of astonishment was noticed, and he suspects that if such exists it has been confused with expressions of fear, since the animal is extremely timid. The sounds recorded are numerous. Boutan concludes that they have not the value of words, but instead represent vague notions or awareness of agreeable, disagreeable, and dangerous situations or events. He characterizes the vocal expressions as a pseudo-language.

This investigator's most important conclusion is that the vocal expressions of the white-cheeked gibbon are instinctive and practically independent of the experience or special training of the individual. He carefully guarded his subject from the vocalizations of its species throughout the period of captivity and observed that when

it first produced a call it was the cry characteristic of the species. In comment on this important conclusion Boutan says that his subject responded to her name, clearly expressed certain desires in action, but never produced new sounds or imitated the sounds of her human caretakers. The gibbon, he says, does not characterize objects by sounds. The latter indicate only a state of feeling; not the precise nature of food, but only the degree of satisfaction caused by it.

The cry of the white-handed gibbon is graphically described by Tickell who, passing from consideration of habitat and gregariousness to vocalization, says:

It is rare to see a solitary one; occasionally, however, an old male will stay apart from the flock, perched on the summit of some vast tree, whence his howls are heard for miles around. The forests which these animals inhabit, resound with their cries from sunrise to about 9 A.M. Their usual call may be thus rendered.

The sounds varying from the deep notes of the adults to the sharp treble of the young ones. During these vocal efforts they appear to resort to the extreme summits of the loftiest trees, and to call to each other from distant parts of the jungle. After 9 or 10 A.M. they become silent and are engaged feeding on fruit, young leaves, buds, shoots and insects, for which they will occasionally come to the ground. (Tickell, 1865, pp. 196-197.)

Referring to the captive siamang which he had opportunity to observe on shipboard, Bennett states:

The sounds he uttered were various: when pleased at a recognition of his friends, he would utter a peculiar squeaking, chirping note; when irritated, a hollow, barking noise was produced; but when very angry, and frightened, or when chastised, the loud guttural sounds of *ra, ra, ra,* invariably followed. When I approached him for the first time in the morning, he greeted me with his chirping notes, advancing his face at the same time, as if intended for the purpose of salutation; but I did not feel desirous of trying the experiment, as I knew these animals were not in the habit of kissing, and I well knew they were in the habit of biting. (Bennett, 1834, II, 154.)

Citing Müller as his authority, Huxley (1863, p. 27) says:

All observers testify to the prodigious volume of voice possessed by these animals. According to the writer whom I have just cited, in one of them, the Siamang, "the voice is grave and penetrating, resembling the sounds gōek, gōek, gōek, gōek, goek ha ha ha ha haaāāā, and may easily be heard at a distance of half a league." While the cry is being uttered, the great membranous bag under the throat which communicates with the organ of voice, the so-called "laryngeal sac," becomes greatly distended, diminishing again when the creature relapses into silence.

The vocalization of the siamang is most fully described by Welch:

The voice of *Symphalangus syndactylus* is remarkable for the variety of cries, which follow rapidly one after another, and at least five sounds can be distinguished, with all of which the gular bag dilates. Anyone with their eyes shut would certainly think there was more than one animal in the cage. These cries are:—

(1) The usual and loudest, best described by the words "woe, woe, woe," &c., repeated rapidly and for a variable number of times, sometimes forty or fifty. Judging from the deafening noise the animal made with the "woe woe" &c. on the first occasion I heard it, I should think it could be heard much further off than an adult *H. hoolock,* but unless one hears two adults shouting against one another, it is very difficult indeed to be certain which of the two has the louder cry.

(2) A gurgling noise, best described by the word "moo," drawn out over several seconds and sounding somewhat like a human being beginning to vomit. It follows rapidly after the "woe, woe, woe," &c., as a rule, and the gular bag dilates to the greatest size with this sound, occasionally reaching a diameter of nearly 8 inches. The "moo" is made mostly during inspiration.

(3) What I can best describe as a wailing-shriek like the word "wair" shrieked out for twenty or thirty seconds and sometimes longer, the voice being alternately raised and lowered a little. It usually follows rapidly after the "woe, woe, woe," &c., and is about as often heard as no. 2—the gurgling "moo." It is, however, louder than the "moo."

(4) A "ho, ho, ho," &c., repeated, as a rule, four or five times. I have only heard it on a very few occasions and it is not nearly so loud as the previous three sounds.

(5) A squeal somewhat resembling the noise made by some Eagles. This is as rare as the "ho,

ho, ho," &c., and not so loud as the first three sounds.

When at rest the gular bag is black in sunlight and slightly wrinkled, but on dilatation it becomes dull red. In its walk *S. syndactylus* is bipedal like *Hylobates*. (Welch, 1911, pp. 357-358.)

Gibbon vocalization and speech, except for the work of Boutan, have been observed instead of studied. Indeed, no aspect of linguistic expression and intercommunication has been investigated thoroughly. Conclusions, therefore, are definitely contra-indicated, whereas research is demanded as condition of progress.

CHAPTER EIGHT

RECEPTIVITY AND ADAPTIVITY IN GIBBON

Of the three chapters in which we have chosen to arrange psychobiological data concerning gibbons, the first and second deal primarily with native, early appearing, or hereditary traits and capacities, whereas the third and present one considers chiefly nurtural influences, acquisitions, and adaptations. There is intimate relation and overlapping, inasmuch as Nature and Nurture, "instinct" and "intelligence," the racially given and the individually acquired are inseparable aspects of biological process. Probably neither is more important in the life of the organism than is the other, and it is only by the artificiality of classification that we are tempted to describe them separately and to compare them as though they might function independently. The word "instinct" seldom appears in this book; the word "intelligence," except as quoted, almost as rarely. We have no horror of the terms, but we are convinced that it is more profitable to deal specifically with the facts of behavior and experience than to hide our ignorance in general terms.

In the chapter on natural history we attempted so to use essential facts of structure and classification, habit and life history as to present a picture of the daily free life of the gibbon. In that on affectivity and its expressions we similarly tried with the meager materials at hand to sketch the emotive life. Always chief emphasis has been placed on behavior, although we have freely used subjective terms in order to increase intelligibility. As we see it, each of these chapters is preparatory to that on adaptivity, for the facts of natural history and of affective life bear intimate and significant relation to the nature and expressions of "intelligence."

We purpose in this, the final chapter on the psychobiology of the gibbon, to gather together what is known of its environmental relations and characteristic forms of adaptation, docility, or educability—terms which we may use interchangeably and without initial attempt at precise definition. Interested rather in the modes, rates, limits, and relations of behavioral adaptation than in its presence or absence, we have arranged the facts accordingly.

Belittling of our undertaking though it may seem, we must initially admit the scientific inadequacy of the materials which are available on the psychobiology of the gibbon. We are eager to point out defects and deficiencies because it seems an excellent way to stir effort toward more nearly accurate and adequate knowledge.

For the natural history of the gibbon we discovered available materials to be meager and fragmentary. In no single direction can one tell with assurance a connected and detailed story of the daily life of this spryest and shyest of the apes. Even more disheartening are the data on affectivity and its modes of expressions. They are crude, incomplete, unreliable, merely glimpses through a clouded glass, and well-nigh valueless, we judge, except as they may arouse our ambition immeasurably to outdo our predecessors in quest of facts, insights, and vision.

But whereas gibbon natural history and affectivity are in a prescientific stage of investigation and descriptive examination, adaptivity has entered upon the obviously scientific phase by virtue of the systematic naturalistic and experimental studies of a single investigator, Louis Boutan. Description of gibbon "intelligence" prior to the publications of Boutan is hopelessly crude and unconvincing. Happily, his contributions constitute an outstanding excuse for an otherwise depressing recital. The situa-

tion which our study of the literature revealed has made us feel that where scientific inquiry begins, ignorance is more favorable than misinformation, for the latter implies bias, prejudice, preconception, and the false assumption of knowledge.

RECEPTIVITY—THE MODES OF SENSE

To the average user of this book we doubtless shall be equally intelligible whether we employ the objective technical terms receptor, effector, and reaction, or the subjective terms sense organ, organ of expression, and sensory response. Either way there are implications a plenty, and as our knowledge of the train of psychobiological facts doubtless is nearer its beginning than its completion, we resolutely decline to label ourselves as objectivistic or subjectivistic. Instead we shall endeavor to be practical and pragmatic, thus satisfying neither extreme party, and we trust sufficiently irritating all to increase desire for information and understanding.

It appears that the morphologists have devoted considerable attention to the nervous system of the gibbon. Witness such admirable structural studies as those of Flower (1863), Kohlbrügge (1890-91), Waldeyer (1891), and the invaluable digests and bibliographies of Keith (1896) and Sonntag (1924). "The brain in the Gibbons," writes the latter, "is intermediate in its characters between those of the Cercopithecidæ, on the one hand, and those of the larger Simiidæ on the other. Moreover it indicates in some ways the path pursued by the latter in evolution." (Sonntag, 1924, p. 282.)

In what for the psychobiologist is by far the most illuminating and generally useful description of the gibbon brain in comparison with that of other primates, Tilney (1928, I, 405 ff.) describes the configuration of the cerebral hemispheres as little more advanced in many respects than those of baboon and rhesus monkey. The principal fissures and lobations agree closely. In some ways, according to this authority, the gibbon brain is more complex and highly developed than that of the monkeys; in other respects, somewhat less so. There is, Tilney writes:

a richness of convolutional pattern in the occipital lobe, which does not exist in either of the other two forms. This fact, taken in conjunction with the much reduced appearance of the superior colliculus of the midbrain, indicates that in the gibbon most of the actual supervision of vision has been transferred to the occipital lobe. The fissures in the temporal lobe, especially the superior temporal fissure, are well developed and this latter has connected with its extremity a well-defined angular gyrus.

The fissures of the basal surface of the frontal and temporal lobes give these regions an extremely simple appearance. In fact, the impression obtained from a survey of the cerebral hemispheres in gibbon allies this form much more closely with the group here identified as intermediate primates. Certainly, the superficial appearance of the gibbon's cerebral hemisphere places between it and the more highly complex endbrain of the great anthropoid apes a wide interval, so wide as to justify the opinion that in descent, the lineal relation between the gibbon and the anthropoid, however direct, must be quite remote. (I, 415-416.)

Of the "sense organs" Sonntag (1924, pp. 314-316) remarks that tactile corpuscles are present in the skin of apes and man; that the anthropoid eye, in its general anatomy and so far as examined, is similar to that of man; that the ear of apes also is essentially like the human; and that other types of receptor which undoubtedly exist in each of the anthropoid apes have not been studied. We note, however, that Kunze (1915, pp. 651-659) has described the papillae of the tongue in gibbon and siamang.

Evidently then structural neurology has little to offer relative to the receptivity or modes of sense in gibbons. This is a regrettable situation which suitable provision for anthropoid research should presently alleviate.

Aside from structural evidences of modes and characteristics of receptivity there are those from general behavior, but on searching the literature for pertinent data we discovered no reports of either naturalistic or experimental examination of any mode or aspect of sense. Even the conspicuously

important special senses have not been surveyed, much less studied intensively and thoroughly. And far more surprising and discouraging is the discovery that naturalistic or field observation of the animals has yielded almost no scientifically acceptable information.

It appears then that the sensory anatomy and physiology, like the sensory psychobiology, of this great family of apes are virtually untouched. Where we need established and well-correlated assemblages of fact appear chance observations, which are fragmentary, unverified, and often we fear unverifiable, inferences, opinions, and surmises.

Combining what few established structural and behavioral data the literature supplies as basis of tentative statement, it may be hazarded that vision and hearing are highly developed modes of receptivity in the gibbon. Indeed, conditions of life suggest that hearing may be more acute than in most other primates; and the nature of its vocalization prepares us for discovery of a complexity of auditory receptivity comparable with that of man.

Pocock, emphasizing the importance of acute hearing in the life of the gibbon, points to a structural character which he thinks may be indicative. "In this connection it is important to note that of the two Apes inhabiting W. Africa, namely the Chimpanzee and the Gorilla, and of the two inhabiting the East Indies, namely, the Orang and the Gibbon, the larger and stronger has in each case small insignificant ears and the smaller and weaker large ears." (Pocock, 1905, p. 180.) Presumably this author refers to the external ear or possibly exclusively to the pinna. In either event the biological significance attributed to the structural differences appearing among the anthropoid apes is doubtful. Yet it may very well be true that the sense of hearing is more highly developed in gibbon and chimpanzee than in orang-outan, gorilla, or even in man.

Sonntag, referring to the same observation and quoting Pocock, further remarks: "The external ears are most prominent in Man and the Chimpanzee, for they are concealed by the hairs in the Gibbons, Orang and Gorilla. Their small size in the Gorilla and Orang permits them to be easily hidden." (1924, p. 316.)

In view of all that is known of the wild life of the gibbon, and especially of the nature and demands of its environment and its social relations, one might expect it to depend for avoidance of dangers and escape from aggression on the special senses of hearing and sight. Obviously it is adapted to quick flight instead of to defense or aggression. In this respect it contrasts most markedly with the gorilla. Although we should, for such reasons, expect gibbon vision to be of an order of acuteness and complexity comparable with our own, available data justify only the inference and not the assertion that the animals' amazingly accurate spatial adjustments are conditioned by visual data. Of the system of visual impressions and perceptions—color, brightness, form, size, distance—we are profoundly ignorant. The same degree of ignorance obtains for the other modes of sense. It is impossible even to list them; much less may we describe them.

We would not leave the reader with the impression that there are no dogmatic assertions concerning the senses in the literature on gibbons. As a fact there are a great many statements based upon casual observation or inference from what has been read. They apply, however, almost exclusively to sight and hearing. Of the cutaneous, kinaesthetic, and chemical sense modes nothing apparently is known, and, strange to say, nothing is asserted. It is our opinion that these scattering, unsupported statements are negligible in value, and we have taken little pains to cite or otherwise give credit for them.

One might, it is true, from knowledge of modes of sense in man and other primates, and very general acquaintance with the natural history and behavior of gibbons, write an interesting and perhaps also substantially correct general description of

the receptive equipment of this family of apes. But it would obviously be of inferential instead of observational origin and profitless except as an intellectual exercise or as a species of prophecy, to be subjected to the test of experimental inquiry and measurement.

"INTELLIGENCE"

Prior to the early years of the nineteenth century the adaptive behavior of gibbons seems to have escaped critical examination and remark, although it frequently attracted attention and provoked comment and characterization. It remained for Sir Thomas Stamford Raffles, during his governorship of Bencoolen, Sumatra, to arouse scientific interest in these apes by notable additions to naturalistic information. His efforts were partially robbed of their value by serious disagreement with the French naturalists Duvaucel and Diard, whom he had employed as assistants. Raffles himself published little on the behavior of gibbons, and the notes of Duvaucel were used by Cuvier in his natural history of mammals, which by virtue of this unique contribution becomes the most valuable of our early sources of light on the intelligence of the siamang and Hylobates.

Referring to the siamang, Duvaucel writes:

> This species is very common in our forests [those, namely, in the neighborhood of Bencoolen, in Sumatra], and I have had frequent opportunities of observing it, as well in its wild state as in bondage. . . . These animals are slow and heavy in their gait; they want confidence when they climb, and agility when they leap, so that they may be easily caught, when they can be surprised. But nature, in depriving them of the means of readily escaping danger, has endowed them with a vigilance which rarely fails them; if they hear a noise which is strange to them, even though they be at a mile's distance, fright seizes them, and they immediately take flight. When surprised on the ground, however, they may be captured without resistance, being either overwhelmed with fear, or conscious of their weakness and the impossibility of escaping. At first, indeed, they endeavor to avoid their pursuers by flight, and it is then that their awkwardness in this exercise is most apparent. Their body, too tall and heavy for their short slender thighs, inclines forwards, and availing themselves of their long arms, as crutches, they thus advance by jerks, which resemble the hobbling of a lame man whom fear compels to make an extraordinary effort. (E. Geoffroy-Saint-Hilaire and F. Cuvier, 1824, *Le Siamang,* p. 1.)

This often quoted account of the behavior of the siamang has been adversely criticized for reasons which will presently appear.

Of the agile gibbon Duvaucel offers the following account:

> These apes, which live more frequently isolated in couples than in families, are the least common of those found here [in neighborhood of Bencoolen], since for five or six Wouwous one may see a hundred siamangs. Very different from the latter in its surprising agility, it escapes like a bird, and like a bird can only be shot, so to speak, flying; scarcely has it perceived the most distant approach of danger when it is already far off. Climbing rapidly to the tops of the trees, it there seizes the most flexible branches, and balancing itself two or three times to secure its equipoise, and acquire a sufficient impetus, it thus springs successively, without effort as without fatigue, to a distance of forty feet.
>
> As a pet or domestic animal it exhibits no extraordinary faculty: it is less clumsy than the siamang, its shape is more slender, its movements are more prompt and graceful, but its manners are less lively than those of the monkeys; and in its long slender arms, in its short bandy legs, one is far from suspecting such vigorous muscles and such marvelous agility.
>
> Nature, however, has not bestowed upon it a large portion of intelligence. In this respect it is in no way superior to the siamang, both are deprived of high forehead; this is one of the great points of coincidence between the two species. What I have myself seen, however, convinces me that it is susceptible of some education; it has not the imperturbable apathy of the siamang; it may be frightened or pleased; it flies from danger, and is sensible of good treatment; it is gluttonous, curious, familiar, and sometimes even gay and lively.
>
> Though deprived of the guttural sac so remarkable in the siamang, its cry is very nearly the same; so that it would appear that this organ does not produce the effect of increasing the sound usually attributed to it, or else, that it must be replaced in the present species by some analogous formation. (E. Geoffroy-Saint-Hilaire and F. Cuvier, 1824, *Le Wouwou,* p. 2.)

Rennie (1838, p. 166) is authority for the statement that Raffles disagrees with

Duvaucel in his characterization of the siamang and estimate of its "intelligence," since he speaks of it as bold and powerful, but easily domesticated, and so sociable and affectionate that it is content only when in company with those to whom it is attached. Possibly this is fair to Raffles, but our search has discovered in his publications only a few sentences relating to behavior and they supply little and indefinite information. Unfortunately the notes and manuscripts of Raffles were destroyed by fire.

In the same period with the work of Raffles, Duvaucel, Diard, and Horsfield in Sumatra, appeared the publications of Harlan who in his meager notes on the behavior of a specimen of Bornean gibbon, *H. concolor,* ventures the assertion that this ape possesses "all the docility and intelligence characteristic of the orangs." (Harlan, 1825, p. 230.) Presumably he was using orang in the inclusive sense to designate both orang-outans and gibbons. If not, his guess certainly is far from correct since the orang-outan is undoubtedly far superior to the gibbons in adaptivity of behavior.

The following account by Bennett of the behavior of a young siamang is strikingly at variance with the statements of Duvaucel:

His look was grave, and manner mild, and he was deficient in those mischievous tricks so peculiar to the monkey tribe in general. In only one instance did I experience any mischief from him, and that was in his meddling with my inkstand: he seemed to have an extraordinary penchant for the black fluid—would drink the ink, (by placing his finger in the inkstand, and then sucking it,) and suck the pens, whenever an opportunity offered of gratifying this morbid propensity: his black coat did not suffer from his dabbling in ink, unlike many of the human species, who suffer both in constitution and apparel from meddling too much with it.

There was a degree of intelligence in the animal, beyond what is usually termed common instinct. These little miniatures of men, (as they are satirically termed,) are said to possess more sagacity than other animals, and to be a close connecting link between the "powerful lord of the creation," and creatures of an inferior genus. If it be true, as I have heard asserted, that intelligence is written in legible characters on the os frontis of the monkey tribe, I beg to add, that mischief and cunning also beam in their eye.

One instance of a very close approximation to, if it may not be considered absolutely an exercise of, the reasoning faculty, occurred in this animal. Once or twice I lectured him on taking away my soap continually from the washing-place, which he would remove, for his amusement, from that place, and leave it about the cabin. One morning I was writing, the ape being present in the cabin, when casting my eyes towards him, I saw the little fellow taking the soap. I watched him, without his perceiving that I did so; and he occasionally would cast a furtive glance towards the place where I sat. I pretended to write; he seeing me busily occupied, took the soap, and moved away with it in his paw. When he had walked half the length of the cabin, I spoke quietly, without frightening him. The instant he found I saw him, he walked back again, and deposited the soap nearly in the same place from whence he had taken it. There was certainly something more than instinct in that action: he evidently betrayed a consciousness of having done wrong, both by his first and last actions;—and what is reason if that is not an exercise of it?

When he walks in the erect posture, he turns the leg and foot outwards, which occasions him to have a waddling gait and to seem bow-legged. He would pace the deck, being held by his long arm; and then had a resemblance to a child just learning to step. The limbs, from their muscular and strong prehensile power, render the animal a fit inhabitant for the forest; enabling him to spring from tree to tree with an agility that we have frequently witnessed him display about the rigging of the ship: he would pass down the backstays, sometimes hanging by his hands, at others walking down them in the erect posture, like a rope-dancer, balancing himself by his long arms; or he would spring from one rope at a great distance to another, or would drop from one above to another below.

Being aware of his inability to escape pursuit, when running on a level surface, his first object, when about to make an attack, was to secure a rope, and swing towards the object he was desirous of attacking; if defeated, he eluded pursuit by climbing out of reach.

He has an awkward manner of drinking, by which the liquid is much wasted: he first applies his lips to the liquid, throwing the head up, which in some degree may be attributed to the prominency of the lower jaw: and if the vessel in which the liquid is contained should be shallow, he dips the paw into it, and holding it over the mouth, lets the liquid drop in. I never observed him lap with the tongue when drinking; but when tea or coffee was given to him, the lingual organ was carefully protruded for the purpose of ascertain-

ing its temperature. This display of caution was not confined to this species of ape, as I know of several others which will do the same, when hot tea or coffee is given to them; shaking their sapient head violently, if they are heated by the liquid; but still, undeterred, will wait patiently until the hot liquid becomes sufficiently cool for bibulary purposes. (Bennett, 1834, II, 154-158.)

The Bennett soap story is a stock anecdote, indicative perhaps of certain characteristic mental traits of gibbons, but of very uncertain value to the critical student of psychobiological phenomena.

On considering all of the facts presented by Duvaucel and Bennett in the light of our general knowledge of the structural characters and life history of the siamang, and of the relations of behavior to stage of development in the great apes and man, we have reached the conclusion that the descriptions are not necessarily inaccurate or contradictory, but that instead Duvaucel and Bennett may have observed accurately and adequately described the behavior of differing specimens. Bennett, it is reasonably certain, studied an immature male which was characteristically friendly, lively, and docile. Duvaucel, with knowledge of many individuals, may have been influenced chiefly by the behavior of the mature, senile, or ill conditioned. We are inclined to agree with most other critics and commentators that Bennett's description is more closely applicable to the behavior of the average captive specimen than is that of Duvaucel; and we are convinced that the apparent discrepancies in their reports are due to incompleteness of description. Had they indicated sex, age, and physical condition as well as species, they would have supplied essential basis for comparison.

Tickell, who otherwise contributes nothing of note to our knowledge of adaptivity, remarks that young gibbons which he observed in captivity were "generally feeble, dull, and querulous, sitting huddled upon the ground, and seldom or never climbing trees." (Tickell, 1865, p. 198.) We quote his statement because of its obvious importance for studies of behavior. Unless pains be taken to render conditions of captivity favorable for these animals, their behavior is almost certain to be unusual or abnormal and descriptions of it inapplicable to the species.

An entirely secondhand account of what was then known of the adaptive behavior of the gibbon is presented by Figuier, whose pertinent conclusion is thus expressed: "These Monkeys [gibbons] are the least intelligent of the group we are now examining: the structure and volume of their brain, as well as their actions while in a state of captivity, put this fact beyond a doubt. But it would not be just to say, as some naturalists have done, that they are destitute of all intellectual faculties. The results of experience are opposed to this assertion." (Figuier, 1870, p. 586.) And by contrast Garner (1900, p. 276) remarks: "The gibbon is the most active and probably the most intelligent of all apes."

A bit of evidence not without value in connection with a study of gibbon "intelligence" has been provided by Candler, whose interesting observation unfortunately cannot be safely interpreted without critical reëxamination and supplementation.

As, day after day, I have ridden through the jungle, it has seemed to me that the Hoolocks work their ground systematically in their search for food, just as the planter plucks one section of his tea to-day and another section on a distant part of the garden to-morrow. For I have found them filling the air with their cries along a particular stretch of jungle-road one day, whilst the next day not one was to be heard; then, perhaps, a week later they are back again in the same place. Living as they do in communities, they are constantly on the move, and from what we know of their great intelligence, it seems to me highly probable that their movements are guided by very definite plans, and that very probably they have some sort of government system. (Candler, 1903, p. 188.)

By P. Chalmers Mitchell (1912, p. 209) the gibbon is ranked as less intelligent than the great apes, although of young specimens he says they "soon become docile and are always gentle and friendly. One of

those now at the London Zoölogical Gardens has been taught to swing round and round a bar holding on by his hands, and to stop and reverse at the word of command."

The gibbons, according to Debeaupuis (1924, pp. 137-138), are adjudged from the structure and volume of the brain to be the least intelligent of the "anthropomorphic monkeys." They are, however, excellent observers, equipped with sharp eyes, and extremely alert and active they miss nothing.

From the unpublished notes and manuscripts of Doctor and Mrs. Spaeth we have already, and in other connections, quoted descriptions of gibbon behavior which indicate marked docility and the power of rapid adaptation during early life to conditions in captivity.

Considerable importance must be attached to the well-established fact that captive gibbons seldom are trained to any kind of work or useful service, aside from the performance of simple tricks or acrobatic exercises. Their relative inaptitude for such training and for systematic labor may be referable in part to adaptivity and in part to affective traits.

We have exhibited accounts of the intelligence of gibbons rather for the sake of historical completeness and in order to indicate the natural development of knowledge than because of their scientific value. Indeed, it is evident that the scientific study of gibbon intelligence was not undertaken by any of the authorities thus far mentioned. We propose now, in contrast with the casual observational contributions, to present more general and systematic discussions of intelligence.

The earliest general descriptions of anthropoid behavior, including that of the gibbons, continue in many respects the best available. They are the previously quoted *Natural History of Monkeys, Opossums, and Lemurs,* which we have attributed to Rennie (1838), and *The Natural History of Mammiferous Animals* by Martin (1841). The former we consider excellent as a summary account of the prescientific period of acquaintance with anthropoid apes, and the latter we value even more highly because the writer assumes a larger measure of responsibility for the coördination and evaluation of his materials. Again we state that no one who wishes to familiarize himself with the history of anthropoid psychobiology can afford to neglect either of these natural histories.

The publications of Forbes (1894), Keith (1896), Elliot (1913), Heck (1922), and Sonntag (1924), have values in this connection peculiar to themselves. In no instance are they comparable with the works of Rennie and Martin. What Forbes in his *Handbook to the Primates* offers on gibbon adaptivity is entirely incidental to taxonomic description. This is true also of the more extensive, but for the student of behavior less convenient and less readable, work of Elliot. Keith has limited himself chiefly to summarizing and presenting important references on the morphology of the anthropoids, and Sonntag similarly specializes on morphological materials. The *Tierleben* of Brehm (Heck) admirably brings the accounts of Rennie and Martin to our times. It is readable, although often poorly arranged, and apparently fair and reliable.

The only approach to a systematic critical examination of gibbon "intelligence" of which we have knowledge is that of Mahoudeau, who in an article of promising title devotes his attention almost exclusively to the seemingly contradictory observations of Duvaucel, Diard, Raffles, and Bennett. By way of introduction he points out that the gibbon is of particular interest and value as object of study because recent paleontological discoveries indicate that it is an archaic form which perhaps possesses many characteristics similar to those of man's anthropoid ancestor. The encephalon, for example, is characterized as "primitive" and, therefore, capable of indicating to us characteristics of its structure in primitive man.

From the following quotation one gets a

vivid impression of Mahoudeau's special interest in gibbon intelligence and his strong bias in favor of the unity of the animal kingdom.

For Man is not, as was long believed, a privileged being, distinct and completely different from those living about him. The basic form of all his organs, as well as the primordial function of his intellectual center are found in the animals, particularly in the monkeys and apes.

Nothing then, constituting the organization of Man is distinctive, unless it be the degree of perfection acquired by his cerebral centers, a perfection which has resulted from an immensely long series of intellectual efforts on the part of his ancestors.

Among the zoological specimens most closely related to the human form in anatomical character and in physiology, one deserves especial attention. Not because it seems at first glance to be so similar to Man; not at all, for because of its small size and arboreally-adapted members it seems to be much less human than nearly all the other Anthropoids; but because the remarkable remains of the great primate fossil unearthed at Java, the Pithecanthropus, have shown that the most inferior in evolutionary degree of all the Anthropoids, was the one which presented in best state of preservation, those traits which must have belonged to our distant ancestors when the human prototypes commenced to separate, to differentiate from their zoological collaterals.

It is for that reason that were all the Anthropoids capable of furnishing the most interesting documents toward the natural history of Man, only one of them could be considered as almost approximating the survival of a form having taken part in our genealogical creation, and, in this capacity, this Anthropoid is for us much more precious than all the others.

This type of Anthropoid which is so archaic is the type Hylobatidae, comprising in the present epoch, many species called Gibbons living in the southern countries of the far East. . . .

Being a very old form, the type Hylobatidae possesses naturally a very primitive encephalon capable in consequence, of giving an idea of what must have been in its rudimentary state the encephalon of our protohuman ancestors; for however great may be the existing difference between the brain of the Hylobatidae and of Man, it is not a matter of structure so much as a matter of difference of degree of evolution. From these facts it results that the intellectual manifestations of the Gibbon ought to be very similar to those of primordial Man, and ought therefore to procure for us information of inestimable value.

Small and weak, the Gibbons, living in equatorial forests, surrounded by enemies, in the midst of perpetual dangers, are very fearful, excessively cautious; moreover, they derive all the advantages of living in bands composed oftentimes of a large number of individuals. Though certain species, such as the Gibbon Lar, are sometimes encountered in a small group of not more than from five to twenty individuals, the Siamang Gibbons and the Houloks generally form troops of fifty and even of a hundred individuals. It is certain then, that the Gibbon is eminently sociable, and that the need of living in a society, the need to which our civilizations owe their origin, is found well developed in the Gibbon; moreover, it is not impossible that the beginning of human societies took place at a time when our ancestors were still being confused with those of the Hylobatidae. The intelligence of animals living in a society is necessarily more developed than that of zoological species which remain solitary; that of the Gibbons ought therefore from their social life to be as advanced as the rudimentary morphology of their brain will permit. It should not be forgotten that representing the most archaic type among the Anthropoids, the Gibbons cannot possess an intelligence similar to that of the Gorilla, the Orang, and the Chimpanzee, all much more evolved than they; but the intellectual manifestations of these primitive primates, whose cerebral morphology is much further removed from Man than any of his congeners, are for that very reason, much more instructive. (Mahoudeau, 1913a, pp. 365-367.)

Relative to the discrepancies between the Duvaucel and Bennett descriptions of siamang behavior, Mahoudeau makes certain acute observations. We permit him again to speak for himself.

It is certain that from the point of view of mental manifestations there exist notable differences among the diverse hylobatine species; but if the Siamang is perhaps less lively, less intelligent than some of his congeners, he does not seem, however, to merit all of the disparaging epithets pronounced by Duvaucel and which are unjustified not only according to the observations of other authors, but also according to some of those belonging to Duvaucel himself, which we will cite a little further along.

But, first, a simple remark: this Siamang which in captivity is so insensible to favorable and to unfavorable treatment, which eats with such indifference, and watches the removal of its food without interest, could it not be otherwise than an animal absolutely stupid, than a simple living mechanism; for does it not rather give the impression of a being comprehending its pitiable situation and to whom captivity is so cruel as to render everything indifferent to him? The Gibbon, an Anthropoid essentially gymnastic and arboreal, should be extremely miserable when his

space and his freedom are curtailed; and then, who could assure us that the disagreeable cry uttered at intervals by Duvaucel's Siamang was not an unhappy exclamation, the despairing cry of an unfortunate captive?

The justice of Duvaucel's statements becomes very doubtful in face of the fact that generally the Gibbons observed in captivity have not been found so sleepy, so apathetic, so deprived of all intellectual faculty, so like living machines as Duvaucel pretends. (Mahoudeau, 1913a, p. 369.)

Peculiarly apt and impressive is Mahoudeau's surmise that the siamang observed by Duvaucel may have been extremely depressed by captivity and resentful of it. The attitude of indifference may lead even the best of observers to mistake high levels of intelligence, insight, or comprehension for dulness and stupidity. Actually this is a frequent occurrence in the relations of man, as observer, to the anthropoid apes.

EXPERIMENTAL STUDIES OF INTELLIGENCE BY BOUTAN AND OTHERS

The French zoölogist, Louis Boutan, has the unusual distinction of first studying the behavior of the gibbon systematically and under carefully controlled conditions over a long period. Interested initially in forms of vocalization and their linguistic relations and significance, he subsequently undertook an exploratory study of methods of adaptation of behavior. His report on pseudo-language in 1913 and on methods of learning in 1914 are pioneer experimental studies in anthropoid behavior of outstanding importance, which somewhat antedate the psychobiological studies of the chimpanzee by Teuber and Köhler and of the orang-outan by Yerkes. Neither of Boutan's publications has received its merited degree of attention from physiologists and psychologists. The reports are not even listed in the extensive bibliographies of such important texts and handbooks as Washburn's *The Animal Mind* (1908, 1917, 1926); Kafka's *Handbuch der vergleichenden Psychologie* (1922), Hempelmann's *Tierpsychologie* (1926); and only the 1914 publication is listed in the *Psychological Index*. Yet these studies hold the same place among publications on anthropoid "intelligence" that Thorndike's monograph on *Animal Intelligence* (1898) holds among experimental studies of mammals which in psychobiological development stand close to the primates. Explanation of this oversight and neglect may be found in the titles and place of publication of Boutan's papers: "Le pseudo-langage" (1913) and "Les deux méthodes de l'enfant" (1914), both appearing in *Actes de la Société Linnéenne de Bordeaux*.

In the previous chapter Boutan's observations on vocalization in the gibbon have been described and his more important results and conclusions epitomized. Thus we have endeavored to exhibit and to emphasize the scientific significance of studies which appear to be of quite extraordinary interest and importance. Naturally after more than a decade of rapid progress in the experimental investigation of problems of behavior, the technique and methodology of Boutan, like those of Thorndike, seem crude and inadequate. Supplementing the content of our previous chapter, as far as the Boutan studies are concerned, we shall now draw primarily upon the content of his second report which is devoted exclusively to adaptations of behavior, and we shall cite from the report on pseudo-language only certain observations which are indicative of adaptive capacity.

During a brief visit to Haut-laos, Indo-China, Boutan was enabled to obtain a very young female specimen of the white-cheeked gibbon, *H. leucogenys,* whose mother had just been killed by a hunter (Boutan, 1913, p. 43). This little creature was eventually taken to France by the Boutans and reared with care and particular attention to conditions of life and experience as related to psychobiological observations. It is stated in the 1914 report that the animal had been under observation for five consecutive years. Of its ultimate fate we are ignorant. This anthropoid subject is almost unique among specimens which have been used for experimental investigations of behavior, for its life history

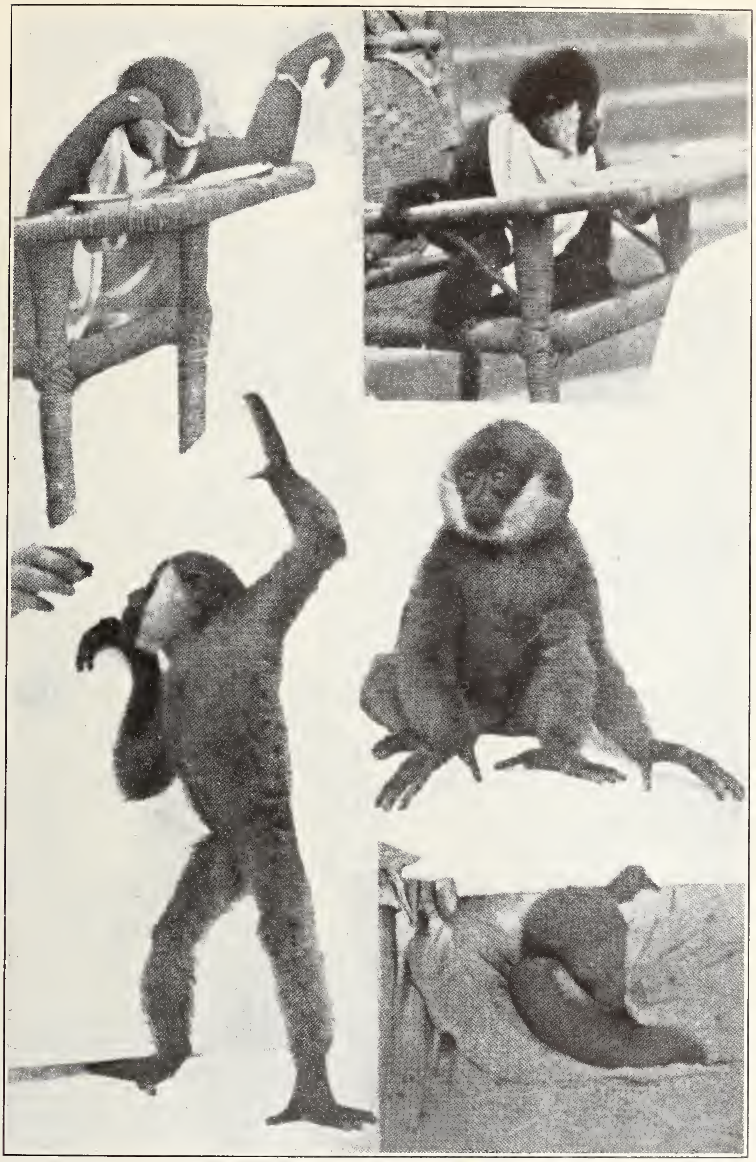


Fig. 40. Pépée, the white-cheeked gibbon studied by Boutan. Courtesy of L. Boutan and Société Linnéenne de Bordeaux.

is intimately known by the scientific observer almost from birth, and, still more important, its mode of life and experience are matters of record. The date of birth is lacking and consequently the exact age, but this is of decidedly minor importance as the age may be estimated to within a few weeks, and knowledge of life history and especially of experience during captivity is a prime essential for the safe analysis, description, and interpretation of adaptations in behavior. With this unique anthropoid subject, and under conditions unusually favorable for observation, Boutan conducted his sustained investigation of certain fundamentally important problems in behavioral expression and adaptation.

From the report on pseudo-language,

two principal lines of evidence bearing on "intelligence" may be drawn. They concern phenomena of imitation and neural fatigue. In addition to the typical call and other vocal expressions of her species, Boutan's gibbon exhibited certain spontaneously acquired vocalizations which it is asserted were not imitations of the sounds made by other animals. Boutan states that she did not imitate any human sound, however clearly pronounced before her. This, in view of the long period of continuous and intimate association of the ape with people, is a result important in itself which indicates either negativeness in the ape or actual inability to imitate human sounds. As we shall have occasion to remark in other connections, the total behavior of the anthropoid apes in situations involving human vocal copy for imitative response is such as strongly to suggest negativeness, or, as Boutan himself expresses it, "refusal" to imitate, and the seemingly superstitious inference of the natives of the African and Indian regions that the animals, dreading to be put to work if they "talk," stubbornly maintain silence! This surmise may not be as ridiculous as it first seems.

Contrasted with the negative findings of Boutan on imitation of sounds by the gibbon is the statement by Mott that a siamang held as laboratory subject imitated sounds made by dogs and guinea pigs (Mott, 1924, p. 1161). In this case neither conditions of observation nor responses are described in sufficient detail to render possible critical evaluation of the observations as opposed to those of Boutan. Tentatively we may conclude from the scanty evidences that the white-cheeked gibbon, at least, does not readily imitate sounds produced by man, whereas under certain conditions the siamang may imitate certain animal vocalizations.

Boutan considers the gibbon's larynx capable of varied sound production, but habitually treating sounds as "dangerous," "advantageous," and "indifferent," the ape attends only to such auditory stimuli as naturally interest it. It manifests no interest in music, having satisfied its curiosity concerning the source, or in human conversation. When its attention is strongly held by compelling visual or auditory stimuli, or problems demanding some novel adjustment, as the price of a much desired reward, fatigue rapidly appears. The image of herself in a mirror, oscillated complexly, at first greatly excited Boutan's gibbon. She attempted to seize the other animal behind the glass, was visibly surprised by her failure, and presently yawned slowly, stretched out on the grass before the mirror, and went to sleep. There was no persistent endeavor to locate the imaged animal. Instead, according to Boutan, his subject quickly perceived the futility of her efforts and became indifferent.

Evidences of neural fatigue (often called mental) and of interest in the mirror image, comparable with Boutan's, will be reported in subsequent chapters also for other types of anthropoid ape. Undoubtedly the facts are of considerable importance, and although much might be said of them speculatively, there can be no doubt that accumulation of observational data will more rapidly advance knowledge and understanding of relations to the psychobiological system of the ape.

The reports of Boutan are brief and his style almost laconic. One must read and reread them in order properly to appreciate observations, interpretations, and reflections. The following sentences, with which an important chapter concludes, we quote in translation primarily to exhibit the author's habit of thought and expression: "Is it really a necessity for the animal to save its attention? If so, the possibility of learning to speak would depend less on the total development of the nervous centers than on the resistance of the animal to an effort of attention." (Boutan, 1913, p. 57.)

Turning our attention now to the second of the reports, which is a comparative study of adaptation in the gibbon and in young children, we shall endeavor to present with reasonable detail and adequacy the essential features of method, result, and

conclusion. Our reasons for extended account of this study are, first, its uniqueness as the first and only experimental examination of gibbon intelligence, and, second, its importance.

The author shall state for himself the general conditions of observation and his objectives.

> I have brought up for five consecutive years an anthropoid belonging to the genus Hylobates. It was isolated from other animals of its species and subjected to no training except that necessary in living with human beings. It learned to sit on a chair at a table and to eat with a spoon. I subjected it to certain experiments to see of what it was capable by itself and compared its actions with those of young infants under the same conditions. I used children young enough not to have language at their disposal and also children who had the use of language. Experiments were similar to those of Thorndike, Kinnaman and other American authors. . . . The instruments which I used, boxes with bolts and boxes with cords, were of the same order as those of Thorndike and Kinnaman. Thorndike shut his animals into the boxes; Kinnaman, and I followed his method, left the animals at liberty where they might open the boxes. My predecessors used hunger as a stimulant; I used appetite and desire for dainty food. . . . I was unfortunate in having only one subject to use. I confined myself to determining the behavior of the animal left to its own resources in face of a given mechanism. The point in which my researches differ from the preceding ones I have mentioned is my comparison with children placed under the same conditions. It is impossible to penetrate *directly* into the consciousness of an anthropoid. We can only judge of his psychological work by exterior manifestations. *Indirectly* we can present the same problems to a child whose definite stage of development we know. The child differs from the man, but the man has been a child. One may use the acts of a child in order to appreciate those of an animal. Many such experiments are needed in order to arrive at precision and to furnish a solid base for the conclusions of the philosophers. (Boutan, 1914, pp. 3-7.)

For the study of problem solution under experimental conditions two small communicating rooms were employed: the one painted yellow served as the subject's workroom; the other, painted black, as the observer's room. The former was well lighted by daylight, the latter was dark except for artificial illumination especially manipulated for purposes of graphic or photographic recording of responses. The wall between these rooms contained two openings: one, closed by colored glass to exclude actinic light, and the other by a slide which could be operated when it was desired to take photographs of the subject. The observer could readily watch the animal, whereas he could not be seen by it. The illumination of the subject's room was supplemented for photographic purposes by a gas lamp. The apparatus for manipulation by the gibbon was fastened securely to a table in the experiment room and so placed that the essential portions of the mechanism faced the observation window. With the experimental situation in readiness, the gibbon was taken into the experiment room in a covered basket by a laboratory assistant, who, placing the basket on the floor, counted "three" distinctly, as signal for the experimenter, unfastened the cover of the basket and retiring from the room closed and fastened the door. Thus the animal was set at liberty in its workroom without the possibility of influence by the experimenter and without knowledge of his presence as observer.

The apparatus employed by Boutan undoubtedly was suggested by his knowledge of devices used by Thorndike in his study of "associative processes" in the cat and by Kinnaman in his similar study of the behavior of monkeys. The mechanical devices were extremely simple and obviously designed with a view to exhibiting methods of solution of novel problems. Two types of apparatus were employed: the one depending upon visible mechanisms, and the other upon hidden mechanisms. In all cases the apparatus consisted of a wooden box, 25 by 35 by 20 centimeters, either one or two sides of which were covered with wire netting instead of doors so that food placed in the box might readily be seen by the subject. A small hinged door in the top of the box when opened gave the animal direct access to the reward or lure. This door was fastened in the various experiments by more or less complex visible or invisible

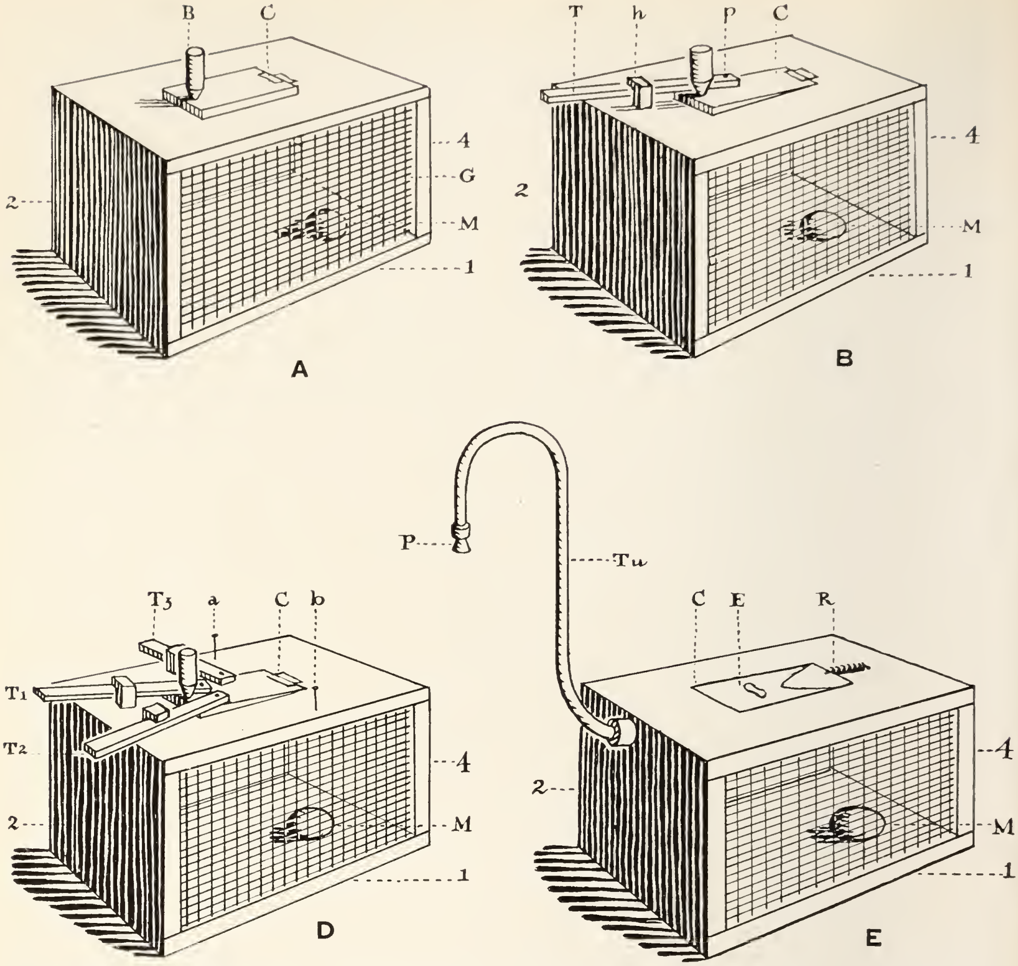


Fig. 41. Boutan experiment boxes, A, B, D, E, redrawn from Boutan, 1914, pp. 15-17. Courtesy L. Boutan and Société Linnéenne de Bordeaux.

mechanisms, and the appropriate manipulation of these mechanisms constituted the required adaptation of behavior to the experimental situation.

For the first type of problem, that with visible mechanisms, four similar boxes were used. In the first, box *a,* the hinged door at the top of the box with wooden button on the outside by which it could be pulled open, was left unfastened; in the second, box *b,* a horizontally moving pivoted wooden bar served to prevent the opening of the door until the bar had been pulled to one side; in the third, box *c,* the door was held shut by two such wooden bars which worked in opposite directions, and in the fourth, box *d,* there were three such bars. Essential features in the construction of these problem boxes appear in the accompanying illustrations.

The apparatus with hidden mechanism consisted of a box like that already described, the hinged door of which was held in place by a bar within the box, invisible from without, and in addition a spring was so arranged that the door opened as soon as the bar was withdrawn. On one of the vertical sides of the box was fastened a tube in the form of a crook through which a light wire passed from one end of the

bar to a wooden knob on the opposite and more remote end of the tube. A slight pull of the knob caused the door to spring open. Following his description of this experimental apparatus, Boutan cleverly remarks: "One may criticize these instruments as being childish, but I reply that is exactly my purpose, a study of a bit of childish work." (Boutan, 1914, p. 18.) Had he been inclined to verbosity he might have added that in so far as the apparatus was appropriate to the human adult, it was inappropriate to the human infant, child, or anthropoid ape.

In the following condensation of Boutan's account of observations and conclusions we have quoted only portions literally translated. The remainder is free translation, paraphrase, or presentation of essentials in our own language.

In her first experience on June 6, 1910, in the box *a* experiment, the gibbon Pépée hesitated a moment after the basket was uncovered, then sprang to the table, discovered the lure (bananas) in the problem box, and gave her characteristic cry of satisfaction. She fumbled at the netting on the one side of the box, then on the other, trying to push her hands through the mesh. Then she examined the top (solid face) of the box, and noting the button, grasped it and opening the door seized a banana and ate it. The problem obviously was an extremely simple and easy one.

When confronted with the box *b* problem, Pépée promptly jumped to the table, examined the lure, and attempted to open the door with the button. Prevented by the sliding bar or lever, she tried to lift the latter in the same manner as she pulled the button. Checked in this she again grasped the button; checked here also she returned to the bar, pushed it laterally, opened the door and obtained her reward. Boutan notes that the pushing of the bar appeared to be accidental.

In her first experience with the box *c* problem, the gibbon examined the new arrangement of bars for several seconds. She then pushed bar 1 laterally without attempting to raise it and without touching the button. Turning her attention to bar 2 she pushed it and simultaneously jumped from the table. Returning she opened the door. The immediate repetition of this experiment convinced the observer that the gibbon now moved the bars horizontally without attempt to raise them.

When this same problem was presented after an interval of three days Pépée pushed bar 1 so vigorously that it sprang back to its original position. Again she pushed it, then moved bar 2 and opened the lid.

When box *d* with its three bars was presented, Pépée pushed them in the order 3, 1, 2. Bar 2 had been pushed so far that it prevented the opening of the door. Without appearance of astonishment the animal pushed bar 3 back part way, then moved bar 2, and presently succeeded in opening the door. Boutan considers significant the fact that in this trial she first attacked bar 3, the one new to her, and then worked successively bars 1 and 2.

In subsequent trials the box was fitted with stops to limit the action of the bars, and Pépée, using both hands, quickly and without hesitation operated them successfully.

The experimenter points out that evaluation of these results necessitates critical consideration of three groups of factors: (1) the gibbon's prior experience with more or less similar objects; (2) the influence of the observer on the animal during the period of work; and (3) the new acquisitions or experiences of the subject during experiments. It is stated that Pépée had certain familiarity with boxes and packages as possible containers of food and would remove covers or pull off strings in order to get at the contents. Whether she acquired this ability through imitation or by independent trial is not definitely known. The influence of the observer was limited, Boutan believes, to the provision of conditions favorable for work. He was invisible to the subject during period of experimentation. Of new acquisitions there

appeared to be several, as the investigator thus indicates. In her first experience with box *b*, single bar, Pépée found herself before a mechanism which she did not know how to work.

She tried to lift it like the button . . . went back to the button . . . returned to the bar. . . . Has she learned from the very first that to open a box the bar must be pushed horizontally and not vertically? . . . The fifth experiment shows this without doubt. . . . This notion is an acquisition of the animal, as we prove by the sixth and seventh experiments where the difficulty becomes much greater. One could even believe that she *generalizes* her *discovery* (which I do not believe) since she applies it immediately to any bar. . . . However that may be it remains that from these first experiments with the boxes and bars the anthropoid by her own means has acquired the notion that one may formulate thus: "To push the bar or the bars in a definite direction opens the box and permits one to take the food." Since Pépée, like other animals of her species, has no word of language at her disposal, the notion in question cannot itself be formulated so clearly in her head. It seems that she might formulate it as a series of associated images at once visual, motor and tactile: the image of the object of which she wishes to get possession, the image of the cover which she must open, the image of the bar which she must push a certain way. I recall what I have already written on pseudo-language: The ape is a talented mimic, *but it is not a man.* It can unconsciously play before us a pantomime. It revives the various impressions of the external world; it has relatively extensive associations, a remarkable physical sensibility, a true aptitude in translating through the play of features its impressions, painful and agreeable. It does not react with the automatism of the hen. It is a talented actor, but like the dog an actor whose rudimentary thought does not formulate itself in its head as in the case of the human actor by the aid of words, but by the aid of sensory images.

The anthropoid has at the same time made another discovery which one is tempted to translate thus in human language. *When she is carried into the experiment room the aid has counted in a loud voice 1, 2, 3, and closed the door; the basket is no longer closed and she may go out freely by raising the cover.* This is a new experience; a new discovery which she does not formulate with the clearness of my interpretative phrases, for the same reason—absence of words. It is however present in the head of a Pépée as a series of auditory associated images whose ensemble constitutes a new notion. This is not the moment to examine how the anthropoid has acquired these new notions. Let us only agree that they are acquired by its own means. This knowledge represents the definitive acquisition of the animal. It has no need, as in training, to pass from the conscious to the unconscious, and the act which it performs in the first series of experiments is not repeated sufficiently to take on the value of an automatic act. (Boutan, 1914, pp. 29-32.)

Passing now to consideration of the problem of an invisible mechanism—hidden bar and spring—presented by box *e*, it would seem that anything resembling insight or understanding of the relations of the mechanism, to the end to be achieved by working it, was rendered impossible by the construction of the apparatus. Invisible fastenings, like many sorts of puzzle familiar to human subjects, invite, if they do not actually necessitate, fumbling, blind trial, and resultant accidental or chance solution of the problem and adaptation to the situation. But what, it is pertinent to inquire, happened in Boutan's experiments with the gibbon?

Initially the experimenter misjudged the effort and attitude of his subject, for the apparatus did not work with sufficient ease and was badly controlled.

The reader will recall that in this problem success depended upon the pulling of a wooden knob attached to the end of a wire which passed through a metal tube to a bar on the inside of the box. As originally presented the mechanism required a pull of three kilos for release of the door. Pépée, on her first meeting with this problem box, looked at the food, seemingly noted the absence of the bars outside the box, attempted to open the door, walked around the box, with a finger traced the outline of the door and tried to pry it open, looked at the cord from which hung a weight of one kilo, touched it lightly with her fingers, returned to the box and then played about the room. Then for some time she alternately examined the box and played in other parts of the room. She tried to open the door with her teeth, but failed. The observer, deciding that the animal would have succeeded in solving the problem had the mechanism been sufficiently sensitive, dis-

continued the experiment, and for subsequent trials modified it so that a slight pull would cause the lever to move.

In the next trial the gibbon carefully inspected the box for several seconds without trying to open it, then played about the room, looked at the cord, tapped a card attached near the end of the cord to attract attention, and grasping the knob pulled it. The box opened with a crash and the animal, startled, jumped to the ground. Later she returned and took the food. There followed several repetitions of the experiment in which the box was opened successfully by manipulation of the cord, but each time the opening of the door startled Pépée, and because of this she seemed to vacillate between conflicting impulses: desire to get the food and fear of provoking a startling occurrence.

Although one may consider the apparatus for this experiment defective, even defects sometimes have values, and it is possible that in this instance more was revealed to the observer by the inadequately controlled problem box than would otherwise have been the case.

For a later series of experiments box *e* was so modified that the mechanism worked easily and without noise, but the gibbon only very gradually lost her fear of the apparatus and during many experiments she hesitated to touch the knob. Finally, however, she achieved sufficient confidence to solve the problem directly. The following description is typical as indicating the inhibitory influence of her initial startling experience.

In a trial relatively late in the series, Pépée

> jumped upon the table, looked at the cord, passed around the box and hung from the pipe [above the box]. This was a gymnastic figure which one calls a "*drapeau.*" From as far away as she could get she struck the cord softly so that it did not open. She again explored the box for a new opening. This occurred several times. Finally she hung from the pipe, made a *drapeau* and at a distance touched the cord and opened the box. This experiment with an animal already fatigued by preceding experiments and not hungry is interesting. It seems to prove that the animal knew she could open the box but visibly was deterred by the phenomenon which had strongly impressed her in the preceding experiments. (Pp. 38-39.)

For yet another series of experiments with box *e* the position of the apparatus was shifted, but the gibbon quickly became familiar with the altered situation and adapted perfectly to it. Apparently the spatial relations of the box in the experiment room only slightly influenced her adapted behavior.

As Boutan says of this experiment:

> The result is that Pépée has made a new discovery which one may state thus: *By pulling the handle the box is made to open and one can get food.* After a time on account of the mistake with the apparatus Pépée acquired another notion. *To touch the handle produces a startling and dangerous phenomenon.* This notion was little by little erased and there remained finally the essential discovery: *Touch the handle, the box opens and one may eat the food.* (Pp. 40-41.)

At this point work was interrupted for a period of approximately three months, during which Pépée was taken to the country and permitted to rest. When returned to the laboratory her memory for the solution of the box problems was tested by the presentation of box *d* with its three bars. When given opportunity, the gibbon jumped to the table and with a single movement of her hand pushed bar 3, then in turn bars 2 and 1. She worked without hesitation.

Immediately following the test with box *d*, box *e* with its invisible mechanism was presented. Pépée unhesitatingly mounted the table, inspected the box quickly and without attempt to open it, looked at the handle, grasped the pipe and pulled the knob by stretching her arm. The experimenter concludes that the new acquisitions achieved by Pépée in these experiments were perfectly preserved over a period of three months.

Discussing his observational data, Boutan asserts that the gibbon learned certain things, or, as he put it, acquired certain new notions, from contact with the experimental situation and without training or tuition. In some instances the perception of relation between a given act and the open-

ing of the box does not result from a single experience, and the animal may have to have several opportunities to manipulate the apparatus before it comes to work deftly, directly, and without hesitation.

> But [says Boutan], that connection once established is fixed abruptly and would give graphically a straight line from that moment. If the notion has need of some touching up in order to become definitive, it grows precise too rapidly, too suddenly for one to say that the animal has contracted a habit. I wish to emphasize this point: that these new notions are too rapidly registered to be considered acquired habits. They are the notions of *instruction* and not of *education*. (P. 43.)

It seems then that Boutan discovered from his observation of the gibbon what was revealed to Köhler in his experimental study of the chimpanzee and to Yerkes in his work with the orang-outan; namely, sudden or immediate adaptation. It is interesting to note that these observers, working independently and without knowledge of one another's results or conclusions, and each biased by Thorndike's descriptions of method of problem solution in the cat in favor of the accidental or trial and error solution of novel problems, made strikingly similar observations and arrived at conclusions which are almost identical.

The phenomena observed by these several investigators were so obviously exceptions to Thorndike's description that each evidently was at once impressed with the suspicion that in the anthropoid apes at least there is another mode of adaptation than that of trial and the elimination of useless movements. Boutan refers to this other method of adaptation in the gibbon as learning with voluntary attention; Köhler, in the chimpanzee, as problem solution with insight, and Yerkes, in the orang-outan, as ideational behavior. The reënforcing character of these several accounts of anthropoid adaptation is particularly worthy of note.

The early experiments with Pépée revealed her visible desire for the bananas in the problem box. She tried to obtain them, but this does not necessarily indicate comparison, judgment, or reflection. It may be only the expression of impulse. Applying the pronouncements of different psychologists to her behavior Boutan remarks:

> A psychologist like Romanes or Morgan, who admits in animals a consciousness somewhat human, will say: in Pépée, under the influence of the desire to take the food, there awakens on sight of the food the representation of the necessary act to raise the cover and introduce the hand, the image of the raised cover, the image of the execution and that of the movements necessary to accomplish it. Naturalists like Thorndike and Kinnaman would say: in Pépée, under the influence of the need to take nourishment, awake suddenly the movements which permit her to take food; the need of taking food brings about immediately the observed movements which are bound up intimately with kinaesthetic sensations. There is not then for the latter authors the independent representation of the necessary act and above all the independent image of its execution. I do not believe that the ape, with a cerebral development inferior to that of man, deprived of speech, associates images in a consciousness somewhat human as Romanes and Morgan seem to admit. Perhaps, however, Thorndike and Kinnaman grant too little to the mental power of the animal, and obviously the psychologists cited above grant too much. (P. 46.)

Throughout the experiments the disappearance of useless movements was observed, but according to Boutan's description and interpretation, the elimination instead of being gradual is immediately achieved and persistent.

> In the third experiment, Pépée, placed in the presence of a button which she knew how to work, of a slide which she did not know, sought to raise the button. It resisted. If she reasoned as a child of the right age, she ought to have been astonished at not seeing the box open as it had previously. In reality, she passed at once to the slide, then returned to the button, and then to the slide, without astonishment. It is nevertheless remarkable that *she limited her efforts to the button and to the slide*. . . . In the fourth experiment also Pépée localized her efforts between the slide and the button. . . . Does it not seem as if her movements were oriented with a certain intuition of the end to be attained? That is not yet quite plain; let us continue examining the experiments. The eighth, for example. Pépée the same day had familiarized herself (experiment 6) with the box of two slides. . . . The experiment repeated immediately, she behaved thus: jumped

upon the table, examined slide 1 and the button without touching them, went around the box and examined the banana, came back to the front and regarded the two slides and the button without touching them; suddenly she grasped the gas pipe and did her exercises for a minute, came back and around the box to the front and pushed slide 1 horizontally; unsuccessful; back to the pipe; later again examined the box, stretched her arm towards slide 2, pushed it and opened the box. With a little imagination and placing in the body of Pépée a human consciousness, it is curious to think what one could deduce from this short scene, as a manifestation of mental life. I conclude, only, that Pépée, not being hungry that day, dissociated under our eyes the different impulses to act, and without seeing in these acts examples of reason, it seems to me difficult to affirm that Pépée had only movements *connected with kinaesthetic sensations and that she did not have a representation of the necessary act and an independent image of its execution.* (Pp. 47-49.)

Her behavior seemed to indicate that Pépée after a few experiences with each problem box acquired confidence in her ability to secure the desired reward, and often, instead of working immediately and directly for it, examined the apparatus, played with it, hesitated, and gave attention to other objects about her. The point is thus illustrated. Confronted with box *e*, Pépée executed a number of acts without obvious determination to work the mechanism. Then

Suddenly the game ceases. She goes back to the box and after various useless efforts *seizes the box with her two arms and tries to detach it from the table.* . . . She approaches the handle, touches it, goes back to play; later she tries to pry up the cover with her finger. Afterward she *lies down upon the box and plays with the spring which closes the door.* I put in italics the point which seems to me most interesting in this long manoeuver. The animal who has used in turn her finger to pry it up, her arms to tear away the box, her teeth to gnaw the spring—does she not show us that she sees the precise end (the open box), independently of a certain movement bound up with kinaesthetic sensations? Here we dissociate the movements and the idea of opening the box which provoked successively these different manifestations.

There is there, if not the first sketch of a veritable reasoning, at least an embryo of judgment. The animal seems clearly to react by a series of movements appropriate to an end, pursued under an influence of an idea. In using successively her finger, her arms, her teeth, our animal shows by a series of attempts that she possesses, up to a certain point, a faculty of understanding which permits comparison, very elementary in kind. These movements appropriate to an end, without being the movements of reason in the human fashion, are not comparable only with those which Thorndike had noticed in the cats. . . . They are, on the contrary, comparable with those which Kinnaman has described with the Macacus rhesus, when that monkey, having failed to work a lock with its hands, tried to open it with its teeth.

One cannot a priori, classify all mammals by the formation of their associations, although for the dog and the cat the severe conclusion of Thorndike is perhaps justified. We must admit that it is not the same with the primates and that one finds with them indications of a higher psychological life. This life is shown particularly in the eighth experiment. Pépée opens the box with the three slides. Curiously she begins with slide 3 which she has not used before. . . . Does she then generalize and formulate in her mind somewhat thus: a slide must be moved horizontally? I do not believe it. It seems to me more logical, given the development of the nervous centers of the anthropoid and its powerlessness to use a true language, even a rudimentary one, to admit that her indefiniteness in the choice of slides does not hold a power of generalization, but on the contrary a lack of precision. Pépée is in the psychological state of a young child who commences to talk and who calls "cheval" all the animals which resemble a horse. The child makes a generalization by ignorance. It has nevertheless its source in a comparison partial and clumsy. The child excels Pépée in having a word for the comparison, but it is not less true that Pépée has the possibility of a comparison and that her movements are directed by an idea. (Pp. 50-52.)

Certain experimental studies of mammals other than the primates have revealed varied modes of attack on problems, a versatility of action which suggests, although it does not necessarily employ, ideational experience. This fact in adaptive behavior some have considered troublesome to those objectivists who would exclude mental factors from their descriptions.

But [remarks Boutan], troublesome or not, it seems to me established in the experiments I have just analyzed and it seems to me difficult to interpret otherwise the manifestations of my anthropoid. In experiments 20 and 21, the use of idea and elementary judgment seem to me extremely clear, and especially, ordinarily, in the normal work of the anthropoid, the discovery of the necessary movement is due to simple chance and

the mind of the animal does not seem to intervene except by vague and unprecise direction. One is able to have an idea, when one is an anthropoid, without thereby being a Newton or a Descartes as to method and if the series of experiments reveals to us the possibility for the anthropoid of making a judgment and perhaps even embryonic reasoning, yet Pépée certainly does not use reason to direct her work.

It is not without hesitation and long reflection that I have arrived at that conclusion. Let us examine her *method of work*. In the first experiments the animal touches tentatively without insisting, passes from button to slide, from slide to button. She registers the precious remembrance of a successful attempt, not the start of her discovery. She knows only in large that the operation of the slide brings about the opening of the box, and she does not know precisely at first the exact direction, to right or left, in which to give the push. If the slide resists on one side, she pushes it from the other. In spite of all, when the animal works the boxes with the visible mechanism we must ask if she does not truly reason more than we think in order to bring about the correct movements. It is not quite the same with box *e*. There we see the animal touch the cord and open the box when not a single reasoning judgment or comparison could guide her or indicate that that cord commanded the opening. We must acknowledge that her method is based solely upon trials, and they are fixed under the influence of awakened attention. Awakened attention does not seem to me to have struck Thorndike and Kinnaman sufficiently. It explains, I think, the progress in the movements towards an end and the abandonment of useless movements without the intervention of reason. It seems to me to play so important a rôle that I shall devote the following chapter entirely to it.

To summarize, Pépée effects her movements *without a clear pre-vision of the act which accomplishes the opening of the box.* We may infer that *she has a vague idea of the movements which conduct to that end.* Her attention, excited by the presence of agreeable food, allows her to remember a useful movement. *The idea that an appropriate movement can open the box is then with her passive and not directive.* I have therefore adopted an intermediate opinion between those mentioned above. With Thorndike, Kinnaman and the naturalists I believe there is not clear pre-vision of the movement to be accomplished; but I believe at the same time there is pre-vision of the end to be attained. With Morgan and the psychologists of the same school, I believe that in the consciousness of the animal the idea of movements is independent of the movement itself; but I depart from them in believing that the idea is passive and not directive of the movements. (Pp. 53-55.)

In his chapter on attention Boutan distinguishes two types which he designates as natural or spontaneous and artificial or voluntary. The former is commonly observed in all mammals, whereas the latter is characteristic of man. Indeed, Boutan goes so far as to speak of the former as animal attention and of the latter as human.

This distinction is similar to one I have made between pseudo-language and language. Pseudo-language and animal attention both exist with animals and man; artificial attention is a human attention. Artificial attention develops truly only when man has conquered, as an instrument, words. With the primates, whose nervous centers approach those of man but who remain deprived of true language, artificial or human attention can only manifest itself as an embryonic state, by flashes and sudden illumination without duration. This helps us to understand the origin of attention. . . .

In a previous memoir [Boutan, 1913] I have reported observations made upon my anthropoid Pépée. . . . In brief, the animal systematically saves its attention. It seems afraid to fix it, and in fact when its attention is strongly awakened, it soon suffers extreme fatigue. I ask myself if, in an animal of superior organization like Pépée, we do not find at once the two different manifestations of attention: animal attention which manifests itself normally in the habitual acts of life; artificial or human attention which manifests itself exceptionally, in a fragmentary embryonic form, in certain particular cases in the primates. In the experiments with boxes Pépée, stimulated by desire for food, manifested the sustained attention of the animal excited by the sight of the food in the box. In certain experiments we have something different, however. In experiment 22, for example, the memory of the noise caused by the spring seemed to destroy the commencement of an artificial attention.

[Footnote:] When for any reason I have multiplied the number of experiments, it has been said to me on my return to the house, "Pépée must have worked more than usual today. She was fatigued and after her lunch went to sleep." If one reflects that the work Pépée did consisted in opening a box in order to obtain food, one cannot attribute the fatigue to muscular effort. I must add that this fatigue was chiefly evident in the experiments with the more complicated apparatus. (Pp. 60-64.)

The general conclusions of Boutan from his prolonged study of the gibbon we thus freely translate.

In these experiments the gibbon Pépée independently acquired certain new ideas. She retained for months the memory of these ideas and the movements appropriate to her successful (adaptive) acts. She lacked prevision of the proper movement, but she foresaw her objective. In her consciousness the idea of movement is independent of the movement itself. Under ordinary circumstances the animal manifests natural or spontaneous attention, whereas in exceptional cases the beginnings of artificial or voluntary attention may be observed. These flashes of the characteristically human sort of attention caused the gibbon extreme effort and rapidly induced fatigue.

In concluding this exposition of the Boutan investigations we may suggest certain criticisms which would inevitably occur to any careful reader of the original reports.

The investigator's experimental technique is far from perfect, indicating the novelty of the undertaking for him, as for Pépée. The problems presented are few and lacking in sufficient variety and gradation of difficulty to yield adequate factual basis for the author's conclusions. His observations also are few, and even where the behavior of the subject is described in reasonable detail, it leaves with the reader the conviction that cases should be multiplied.

Boutan may have made some shrewd guesses—we are inclined to believe that he did; he may have evaluated and interpreted his observations conservatively, sanely, safely. But assuredly radical objectivists will not grant this; and certainly he has taken entirely unnecessary risks of error by limiting his observations to so few types of problematic situation. Our appreciation of the work is so lively that we would not willingly end this paragraph with destructive criticism. Happily there is abundant evidence throughout the reports that the author took his research seriously and gave much thought to his problems, experiments, and the interpretation of results.

After the previous pages had been written there appeared a contribution to the comparative study of intelligence in cats, dogs, monkeys, and anthropoid apes by Drescher and Trendelenburg, which reports certain observations on a gibbon whose sex and species are undetermined. It is particularly worthy of remark that the authors do not include the gibbon among anthropoid apes, and, further, that their observations support the conclusion that this creature behaviorally more closely resembles the monkeys than the great apes.

A few experimental tests made with the gibbon by these authors are thus briefly describable.

Given a rake with which food might be secured, the gibbon behaved essentially as did monkeys which were similarly tested. "It drew in the fruit when it lay in front of the rake, but made no movements to place the rake behind the fruit when it lay further away." (Drescher and Trendelenburg, 1927, p. 618.)

When confronted with a box with removable cover in which it had seen food placed, the gibbon immediately opened it correctly. If placed in different positions, the cover was operated from the correct side if the animal had observed the closing of the box (p. 631). When later the cover of the box was fastened with a bolt, the animal succeeded within three days and after a number of trials in solving the problem. Of its attitude in the experiment the authors remark: It was shy and easily distracted, but extraordinarily alert and interested in the placement of the food. Also it was more skilful manually than the chimpanzees and orang-outans which were observed. Somewhat detailed description of the gibbon's method of operating the bolt indicates very distinctly inferiority of procedure to that of the great apes (p. 635).

We have now completed the presentation of what prolonged and diligent searching of the world's literature has revealed concerning the natural history and behavior of the gibbon. It is little in comparison with the needs of psychobiologists, and it is surprisingly meager and unreliable even

from the non-professional point of view. To mention studies which should be made on the gibbon would be equivalent to offering a program of anthropoid research, so little do we know and so uncertainly. We shall close this section of our book with the optimistic prophecy that before another quarter century has elapsed the life, and especially the psychobiology, of gibbons will be more thoroughly and more accurately known than are those of our domesticated animals at present.

The publications, listed in our general bibliography, from which we have derived especially useful information concerning the life of Hylobates and Symphalangus are: Anderson (1878), Audebert (1800), Bennett (1832, 1834), Blanford (1889-91), Blyth (1844, 1875), Boutan (1913, 1914), Brehm (1922), Broderip (1849), Candler (1903), Debeaupuis (1924), Drescher and Trendelenburg (1927), Elliot (1913), Figuier (1870), Forbes (1894), E. Geoffroy-Saint-Hilaire and F. Cuvier (1824), Harlan (1825, 1834), Heck (1922), Hornaday (1885, 1904), Horsfield (1824), Huxley (1863), van Iperen and Schouman (1784), Keith (1895, 1896), Le Comte (1697), Lewis (1834), Lydekker (1894, 1897, 1904), Mahoudeau (1913, 1913a), Martin (1841), Mitchell, P. Chalmers (1912), Ogilvie (1923), Pocock (1905), Rennie (1838), Robinson (1925), Sanyal (1907), Schlegel (1876), Schmidt (1886), Shaw (1800), Shelford (1916), Sonntag (1924), Spaeth (unpublished manuscript), Tickell (1865), de Visme (1769), Welch (1911), White (1799), Yerkes (1925), Yvan (1853).

PART III

ORANG-OUTAN

ORANG-OUTAN

CHAPTER NINE

STRUCTURAL APPEARANCE, SPECIES, DISTRIBUTION, AND HABITAT OF ORANG-OUTAN

THE order of arrangement of anthropoid types in this work was suggested by geographical relations and degree of arborealness. The gibbon and orang-outan are Asiatic; the chimpanzee and gorilla, African. Furthermore, the order of decreasing structural adaptation for arboreal life and of addiction to it is as above: gibbon, orang-outan, chimpanzee, gorilla. Following this natural order we offer as Part III an account of the behavior of the orang-outan.

Despite early and persistent confusion of this creature with other anthropoid types, unjustified multiplication of species, and many erroneous or inaccurate structural and behavioral descriptions, the scientific literature on this ape is much more extensive, varied, detailed, and reliable, and consequently more nearly complete and adequate than that on the gibbon. But it would be misleading to characterize it as satisfactory, since it is only in comparison with the obviously inadequate data on the gibbon that it appears ample and excellent. Although we know much concerning the natural history and even the psychobiology of the orang-outan, it still must be admitted that, as in the case of the gibbon, we are at the very beginning of our quest for facts and understanding.

HISTORICAL SUMMARY

HASTILY reviewing the content of our historical chapters, we note that knowledge of the orang-outan by the ancients is not well attested. Pliny may have included it among the Syrictae; and according to the inferences of Camper and Tyson from his anatomical writings, Galen probably dissected it. But since Tyson confused the orang-outan with the chimpanzee, we may not place full confidence in his belief that Galen was familiar with the great Asiatic ape.

The vague descriptions by Marco Polo may refer to either gibbon or orang-outan, and we suspect that it is rather the former than the latter. The first to use the name "orang-outang," as far as we have discovered, was Tulp (1641), who, however, misapplies it to the chimpanzee, designated by him as *Satyrus Indicus,* from Angola.

The first unmistakable appearance of the orang-outan in scientific literature dates from 1658, when Bontius published his valuable description. From that time to the middle of the eighteenth century the history of the animal may be traced through such authors as Le Comte (1697), Tyson (1699), Schouten (1707), Leguat (1708), Beeckman (1718), Careri (1727), and Hoppius (1760). Under the name Pygmaeus, the latter author refers unmistakably to the orang-outan, since he describes its coat as ferruginous, not unlike a well-baked brick.

Buffon in his early descriptions mistook the immature and the mature animals for different species, and designated the former or smaller form as Jocko and the larger form as orang-outang. Both forms he believed to occur in Africa and in the Asiatic region. In the 1789 supplement to his natural history, having in the meantime seen a living orang-outan, he partially corrected his error by calling it Jocko and the African chimpanzee Pongo, but he continued to regard both as species of orang-outan.

For another fifty years confusion persisted, as witness the works of Linnaeus (1766), Monboddo (1773), Vosmaer (1778), Camper (1779), Wurmb (1781). The contributions of several of these observers greatly advanced knowledge, especially of the structure of the ape, but it was not until the early years of the nineteenth century that confusion of the orang-outan with the great apes of Africa disappeared. Audebert (1800) pointedly criticized the prevailing usage of terms and resulting confusion of types, and Abel (1818, 1825) definitely stated that the apes of Africa should not be mistaken for or confused with those of the East Indies. Gradually since his time knowledge has accumulated until there is now no vestige of confusion. A useful historical review may be found in Kerbert (1914).

STRUCTURAL CHARACTERS

As much as a century ago competent observers referred to the orang-outan as a rare animal, and its numbers have probably since then decreased. But on this subject we have no reliable information, for census of the anthropoid inhabitants of Borneo and Sumatra has not been taken.

The following attempt at general description of the structural traits which dominate the configuration of this great ape, and enable one to recognize it, is full of relative terms and applies only to the imaginary, average, mature male. The animal is heavy in build, with short thick neck, long arms, short bowed legs, well-developed chest and prominent abdomen. Often it is characterized as unsightly or ugly in appearance, and quite as frequently as sluggish in its activity. The adult orang-outan differs remarkably from the gibbon. The former is large and heavy, with abdomen more conspicuous than chest, clumsy and relatively inactive; whereas the latter is small and light, with large chest and small abdomen, graceful, agile, and extraordinarily active.

Although there is no lack of physical measurements, they are usually incomparable and peculiarly difficult to evaluate because of variety in conditions of observation and methods employed. Some data are drawn from living specimens, but more often they are estimates than accurate measurements. Some are based on freshly killed animals, others on preserved specimens, and yet others on skins, stretched in varying degrees. Having attempted from this heterogeneous collection of data to obtain averages, we finally concluded that it is impossible and that typical selected measurements are more safely indicative of size.

A giant specimen described originally by Clarke Abel (1825, p. 493) as 7 feet 6½ inches in height, is said by Blyth (1841a, p. 837), who subsequently examined it, to have been an immature individual of ordinary size. Referring to mature individuals, and deriving his data from nine males and seven females, Wallace (1869, I, 96-97) presents for the males: height erect, 49 to 50 inches; width of face, 10 to 13½ inches; arm span, 86 to 92 inches. This author further observes that his measurements agree closely with those of other observers.

Hornaday (1904, p. 10) states that his largest specimen measured 54 inches in height, 42 inches around the chest, and 96 inches in arm span or reach. The width of face he gives as 13 inches; the maximal length of hand as 11½ inches; its width, 3¾ inches; and the maximal length of foot, 13½ inches. His paragraph ends with the following somewhat surprising assertion: "The weight of a large, full-grown male Orang is about 250 pounds."

As a matter of fact, data on weight are few and very unsatisfactory. Although the Hornaday statement may well be correct, it probably applies to an exceptionally large male, for a careful comparison of all of the data which we have been able to find seems to justify the statement that the weight of the mature orang commonly varies, as Hornaday himself states elsewhere (1879, p. 447), between 120 and 160 pounds. The females usually are con-

siderably smaller than the males. Seldom are comparable measurements on living specimens given for the two sexes.

For additional data on size see Temminck (1835-41), Schlegel and Müller (1839-44, p. 11), Brooke (1841, p. 57), Blyth (1853), St. John (1862, pp. 21-22), Fick (1895, 1895a), Keith (1896, p. 321), Priemel (1908, p. 79), Knauer (1915, pp. 23-24).

Because of changes in the shape and proportions of the body and in the shape of the skull, special skin growths and growth of the hair, the appearance of the orang-outan alters amazingly during its life history. Not uncommonly systematists have

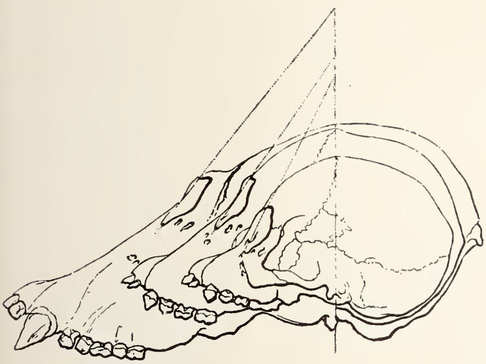


Fig. 42. Changes in the facial outline and cranium of the orang-outan from infancy to maturity. This drawing by Owen is reproduced from Martin, 1841, p. 390.

mistaken young and adult specimens for different species. During infancy and childhood the animal much more closely resembles man in appearance than at any later period in its life history. With growth the facial angle diminishes greatly, the skull becomes more pointed and acquires ridges or crests, the jaws and teeth become conspicuous, and the occasional appearance of cheek pads and a fold of skin over the throat transform the creature into something unrecognizable as a development from the infantile condition. Failure to indicate definitely the stage of an individual's development by exact description of structural conditions or statement of chronological or physiological age, is a perennial source of error, misunderstanding, and illegitimate structural and behavioral comparisons.

A distinguishing mark of the animal is its coat of hair. By this alone it ordinarily may readily be distinguished from every other type of anthropoid ape. Except for the face, ears, palms, and soles, the body regularly is covered with reddish brown hair of varying length and abundance. In important respects it varies extremely with individuality and age. Schlegel and Müller (1839-44, p. 10) observed that whereas in most specimens the color is a handsome red-brown, in some it is a lively yellow-brown, especially on the arms, while in others the head is dark brown. No simple statement suffices for adequate description of coat characters. Yet the condition is simple by comparison with that in the gibbon, for the orang-outan is concolored, and such differences as appear in color, length, texture, and abundance of pelage are not known to be definitely related to sex or species. Pigmentation of the hair apparently tends to increase with maturation, and the coat becomes darker.

It is said that in microscopic structure (Sonntag, 1924, pp. 79-80) the hair of the orang-outan is peculiar and distinguishes it not only from the gibbon but also from the chimpanzee and gorilla.

The skin is brownish, with variations related to age. Certain regions of the body in old males are described as deep brown, purplish, or grayish. There is also a tendency toward a roughness which resembles goose flesh. The depth of pigmentation, which seemingly varies with age, sex, and type or locality, is supposed to be influenced by climatic and endocrine factors and in general to tend to increase with age.

Usually described as large or massive, the head and face of the mature animal exhibit certain distinctive features, conspicuous among which are the prognathous jaws, the pointed appearance of the skull, and the bony crests with the attachments of bulky muscles. In certain individuals appear also semilunar or triangular blinker-like growths on the sides of the face, just

in front of the ears. They are commonly called cheek callosities or pads. It seems fairly well established that these peculiar growths, the biological significance of which is unknown, are not definitely related to age or type, and although Sonntag (1924, p. 76) does not so indicate in his summary statement, many observers assert that they appear only in mature males. We have discovered no single description of them in females, but there appear seemingly authentic records of occurrence in immature males, and we therefore venture the suggestion that they may be a secondary sexual character of the male. Doubtless they have been most often noted and described in the mature or aged male because of their greater size and conspicuousness. During life these pads are turgent, but after death they tend to collapse. They are composed of fat and connective tissue covered by skin which although usually naked is occasionally hairy. In the old male they may become so large as completely to hide the ears, and they thus accordingly increase the breadth of the face and cause the eyes to appear small and close together. Fick (1895, p. 3), however, on the basis of measurements, states that the interpupillary distance is only slightly less than in man.

The eyes of the orang-outan are brown and highly expressive of emotional condition. The nose, although somewhat less prominent than in the gibbon, is slightly elevated above the cheeks and comes to a rather sharp point at the tip, and the nostrils, separated by a thin septum, open obliquely. The external ear, which Sonntag (1924, p. 76) refers to as "degenerate," is small and relatively inconspicuous. Sometimes the lips are referred to as thick and again as thin, but there can be no doubt that the mouth is large and the lips protrusible and extremely mobile.

Whereas the face of the young orang-outan impresses many persons as attractive, interesting, lively, that of the adult is far more likely to repel the observer.

The shortness of the animal's neck is accentuated by a fold of naked skin beneath the chin, which in the mature specimen may be very conspicuous. This fold covers a membranous pouch, the laryngeal sac, which may be either single or divided into right and left portions. Apparently the latter condition is the more common. This sac the animal at will can fill with air, so that it appears like a large goiter. Many authorities (Camper, 1779, 1779a; Rennie, 1838, pp. 87-88; Sandifort, 1839-44; Mayer, 1851; Deniker and Boulart, 1886, pp. 57 ff., 1895; Fick, 1895, 1895a) have suspected, by reason of its communication with the larynx, that its function is to

Fig. 43. Drawing of the mature male orang-outan, Max, captive in Paris, with laryngeal sac inflated. From Delisle, 1895, p. 87, by permission du Muséum d'Histoire Naturelle.

deepen and increase the volume of the voice; others assume that it serves as a cushion for the massive head, and the equally improbable suggestion has been made that it may function as a swimming bladder to assist the animal in locomotion (Vrolik, from Fick, 1895, p. 80).

As previously stated, Symphalangus resembles the orang-outan in having a laryngeal sac, whereas all of the Hylobates lack the structure, and also in being much heavier in build and somewhat less agile and active than the Hylobates. These points suggest the inference that the siamang structurally belongs between the gibbons and the orang-outans.

Like the gibbons, the orang-outan has

very long arms and correspondingly short legs. The hands and feet are long and narrow, as are also the fingers and toes with the exception of the thumb and great toe which are diminutive. Fick (1895, pp. 4-5) refers to the foot as such both structurally and in manner of use.

An odd anomaly long ago remarked in certain specimens of orang-outan is the absence of nail, or even of the whole of the terminal phalanx of the hallux (great toe). At first considered a possible specific difference, this structural peculiarity subsequently came to be regarded as an accident, since it seemingly appears irregularly in specimens from different localities, in both sexes, and at different ages or stages of development. It is said to occur more frequently in females and occasionally on only one side. The condition has commanded a surprising amount of attention and there has been no small amount of speculation concerning its significance. Rennie (1838, p. 86), wisely noncommittal, asks: "Does nature, in this solitary instance alone, disregard the general laws of uniformity by which she has circumscribed the organic development of different species within certain pre-determined and invariable boundaries, and dispense, in the case of the orang alone, with those immutable forms and relations to which the rest of the animated creation has been subjected? Or does this variable and anomalous character arise from an intentional mutilation performed by these intelligent animals upon their offspring, for the purpose of counteracting some disadvantage in their economy, with which we are unacquainted?" For further description of observations and discussion of this anomaly we may refer to Camper (1779), Abel (1818, pp. 365-367), and Schlegel and Müller (1839-44, p. 10).

Our observations, while not enabling us to settle decisively the point at issue, suggest a different explanation from that of Rennie. It may be a case of self-mutilation induced by dietary deficiency, endocrine disturbance, or some neuropathic condition. In the Yale Primate Laboratory the destruction of nail and tip of terminal phalanx of the hallux on both feet by a young female chimpanzee has been observed. It seems far more probable that the condition occurring in the orang-outan is the result of self-mutilation than of mutilation by parents or of accidental variation or abnormality. Against the assumption of variation is the asymmetrical condition sometimes observed.

We have mentioned this seemingly trivial structural matter, which as it happens we consider a valuable lead to certain problems of behavioral maladjustment, because accounts of anthropoid structure and natural history fairly bristle with question-provoking deficiencies, errors, misinterpretations, and assumptions.

As it is our purpose to give only so much of structural description as is necessary for the reader's orientation and to enable him to distinguish anthropoid types and appreciate the importance of structural differentiae in connection with stage of development, sex, species, variety, and individuality, we would conclude this account of external appearance by mentioning a few morphological sources from which the reader may readily take his start in seeking full knowledge of what is known about orang-outan anatomy.

Wurmb (1781), Camper (1779, 1782), Owen (1830-31), Temminck (1835-41), Hartmann (1880), Milne-Edwards (1895), Fick (1895), and Sonntag (1924a) supply useful and reliable general and detailed descriptions of the animal's anatomy; and Keith (1896) and Sonntag (1924) present systematic bibliographies, with brief descriptive statements or summaries, which should prove invaluable to the student of behavior who has occasion to acquaint himself thoroughly and intimately with the results of morphological inquiry.

SPECIES AND VARIABILITY

The early belief in the existence of two or more distinct species of orang-outan (Buffon, 1766; Blumenbach, 1775; Dau-

benton, 1782-1825; Audebert, 1800; Brooke, 1841) has gradually given place to the opinion that there is probably a single

Fig. 44. Orang-outan youth. Julius, the five-year-old male studied by Yerkes. From Yerkes, 1916.

species with local races or varieties. This view was expressed by Schlegel and Müller (1839-44, p. 8) after critical examination of the evidences available to them. And although Keith (1896, p. 322) with caution states that the number of species has not yet been determined, he expresses his belief that there is but one, as the Dutch have thought, and that earlier observers have frequently mistaken age differences for specific characters.

Of orang-outans, writes Rothschild:

> I can recognise only one very variable species, which can be divided up into a number of subspecies. I have characterised 4 such, each with a dimorphic phase, but our knowledge is so imperfect that I only wish to accept these 3 Bornean and 1 Sumatran races for the present, until a fresh lot of material arrives. (1904, p. 439.)

And despite diverse taxonomic views and much discussion of the subject, Elliot, having reviewed the accumulated evidence, inclines to accept the single species, *Pongo pygmaeus* Hoppius, but safeguards his position by stating:

> If the Bornean and Sumatran Ourangs are specifically the same, as at present seems the fact, then Pygmaeus is the proper name for these Apes; but if they are distinct the Bornean Ourang should be called "Wurmbi," the Sumatran "Abelii." (Elliot, 1913, III, 192, footnote.)

Our survey of the taxonomic literature in its relations to studies of the psychobiology of the ape suggests the conclusion that multiplication and confusion of species may be attributed chiefly to ignorance of the age, exact source, and physical status of specimens. In face of the remarkable changes in the appearance which occur between infancy and maturity, the existence of conspicuous individual differences and of local varieties, it would be strange indeed had not a number of species been described.

We may safely assume in this work, and in satisfaction of the special needs of the psychobiologists, that the genus orang-outan (Pongo) is represented by only one species (pygmaeus), and that in all records of behavioral observation pains should be

Fig. 45. Orang-outan maturity. An adult male. Courtesy of F. W. Bond, photographer, and Zoölogical Society of London.

taken to designate the locality or source of the subject, its physiological or chronological age, if determinable, and also to provide

general description of appearance and anthropometric data. Thus, it would appear, misunderstandings and illegitimate comparisons may best be avoided.

The literature provides frequent mention of extreme variability and dimorphism, but there is uncertainty as to the facts. The female is smaller than the male and the two are differently proportioned (Hornaday, 1924, p. 192, Hartmann, 1885, p. 42), exhibiting conspicuous contrasting characters in skull, teeth, cheek pads, and various growths of hair and skin. Of obvious and constant secondary sexual characters there are few. Cheek pads and beard may be restricted to the male, but they are not uniformly present (Temminck, 1835-41, p. 122).

So strongly was Owen impressed with the structural variations in this anthropoid ape that he expressed himself thus emphatically:

> When we review the varieties, already recorded, in the large Orang (*Pithecus Satyrus*) of Borneo and Sumatra, especially in regard to the presence or absence of the nail and its phalanx in the hallux, the occasional supernumerary molar tooth; the length of arm; the intermuscular ridges and crests of the skull; the shape of the orbits; the size and other conditions of the nasal bones; the fore-and-aft extent of the molar series, and the profile contour of the skull; we derive additional proof *that the Simia Satyrus of Linnæus is subject to a greater amount of variety in a state of nature, than has hitherto been observed in any other Quadrumanous species.* (Owen, 1862, p. 176.)

Had the specimens of Owen been classified by age and also by local variety or subspecies, perhaps his conclusions with reference to variability would have been quite different. We have failed to discover convincing evidence that the orang-outan is more variable as individual than are other primates. The appearance of exceptional variableness may, we suspect, safely be attributed to the extraordinary morphological changes during the life history and the existence of an undetermined number of local varieties.

DISTRIBUTION AND HABITAT

Less than a century ago Schlegel and Müller (1839-44, p. 5) and Temminck (1835-41, pp. 365-368) seriously and with critical care discussed the assumption and claims that the orang-outan occurs on the continent of Asia and in Java, Borneo, and Sumatra. They discredited the evidences for Asia and Java, and concluded that it is found only in Borneo and Sumatra. More recently authorities have generally agreed on the fact of limited distribution. Thus Wallace (1869, I, 89-90) observes: "The Orang-utan is known to inhabit Sumatra and Borneo, and there is every reason to believe that it is confined to these two great islands, in the former of which, however, it seems to be much more rare. In Borneo it has a wide range, inhabiting many districts on the south-west, south-east, north-east, and north-west coasts." In Elliot (1913, III, 195) appears the simple statement: "Geographical Distribution: Borneo and Sumatra." We therefore accept the fact of limitation of the animal to Borneo and Sumatra and proceed with examination of the characteristics of its habitat.

In Borneo authorities agree that it has a wide range along the coast, whereas in Sumatra it is said to be found chiefly in the north end of the island. Authorities (Schlegel and Müller, 1839-44, pp. 4, 12; Wallace, 1869, I, 90; Keith, 1896, p. 321; Forbes, 1894, II, 175) further agree that orang-outans prefer low swampy or submerged land near the coast or along river courses. They frequent densely forested regions, avoid those which are abundantly populated by man, and only temporarily, in search of food, seek higher altitudes. Hornaday (1879, pp. 443-444) says:

> The genus *Simia* occurs in northern Sumatra, but its distribution in Borneo is so much more extensive that we may well say Borneo is the home of the orang-utan. There it inhabits that wide belt of low, forest-covered swamps which lies between the seacoast and the mountain ranges of the interior, extending entirely round the western half of the island. But even this great alluvial plain is inhabited by the orang in certain districts

only, although all those portions which are covered by lofty virgin forests *seem* to present the same features. In the Territory of Sarawak, the orang, or "mias" as it is called by the natives, is found along the rivers Batang Lupar and Sadong and their small tributaries such as the Liugga and Simujan. It does not occur at all along the Sarawak or Samarahan rivers, but farther west it is found, though more rarely, from the river Sambas to the Kapuas, which latter lies directly under the equator. It is also found in certain districts along the south coast of Borneo, although its limits there do not seem to be very clearly defined.

CHAPTER TEN

MODE OF LIFE OF ORANG-OUTAN

KNOWLEDGE of the life of the free, wild orang-outan is difficult to obtain, even from the scientific literature. There are many informational sources, but with few exceptions they are secondary instead of original. Of conspicuous interest and trustworthiness are the contributions of Schlegel and Müller, Hornaday, and Wallace. We have listed them in what we consider the order of diminishing importance, for whereas Schlegel and Müller devoted many years to painstaking study of the natural history and structure of the animals, the observations of Wallace and Hornaday were incidental to the duties and other activities of the naturalist-hunter-collector.

The work of Schlegel and Müller, published originally in Dutch (1839-44), is not generally known to English-speaking psychobiologists, although Huxley (1863) based his account of the orang-outan chiefly upon it, and Temminck in his important monograph (1835-41) summarized their naturalistic data, in addition to describing at length the morphological characteristics of the ape. Like Huxley, we shall base our description chiefly on the materials of Schlegel and Müller, supplementing them by references to Wallace, Hornaday, and more recent contributors. It is indeed surprising that there should be so little original material.

Behavioral pictures of the wild orang-outan differ widely from source to source. Thus Sonntag, our most recent compiler and summarist, in briefly characterizing the "habits" of the animal says: "The Orang is the least interesting of the Apes. It lacks the grace and agility of the Gibbons, the intelligence of the Chimpanzee, and the brutality of the Gorilla. It is both wild and shy, and although its strength is immense, it attempts to escape rather than defend itself when it is attacked by Man." (1924, p. 80.) One wonders why the orang-outan should be described as the "least interesting of the apes," and suspects that the form of statement is out of place in a scientific treatise. The remainder of Sonntag's word picture may be criticized as inadequate and in various other respects misleading, especially by comparison with the more detailed and painstaking descriptions of Schlegel and Müller, whose text we freely translate and paraphrase as follows.

> The orang-outan is little inclined to activity, and even during early life it fails to approach the restless liveliness which is characteristic of the gibbons. Hunger alone seems to incite to movement, and this satisfied, the adult animal again lies down to rest. When sitting down the orang-outan usually bends over with head drooping and eyes directed toward the ground. Often perched in a tree he holds fast to a branch with one or both hands, but at times he lets his arms hang relaxed. Thus he may remain for hours, resting in the same spot, quiet and motionless, and only now and then letting his deep rumbling voice be heard. During the day he stays mostly in large trees, climbing from one crown to another. Seldom, except as compelled by old age, does he walk on the ground. (1839-44, p. 14.)

As one reads the varying and usually fragmentary accounts of orang-outan behavior, he is impressed increasingly by the discrepancies due to difference in type, sex, age, or environmental status of the subject. There is indeed no possibility of single safe description of orang-outan behavior, for that of the immature individual differs as much from that of the adult as does its appearance, and there are excellent reasons for believing that the behavior of captive specimens may differ radically from that of the free wild animals. In the following pages we therefore shall endeavor to point the contrast between juvenile and adult behavior, and to state whether a given description applies to the wild or captive indi-

vidual. We are far from believing that captivity necessarily invalidates naturalistic observation, but it is obviously important to consider in each instance the environmental conditions and circumstances under which psychophysiological data are obtained. Captivity may very well transform the attitude, physical condition, and activities of a subject, especially by reason of malnutrition, disease, social deprivation, timidity, dependence on human care, and imitation of human acts. It is then a primary obligation of the student of behavior to state whether his data were obtained from free subjects or from captives. Captivity always means opportunity for adaptation, and quite apart from the satisfactoriness of physical conditions, as contrasted with freedom, it has both advantages and disadvantages for scientific inquiry.

LOCOMOTION

As a strictly arboreal primate the orang-outan differs conspicuously from the gibbon in its slow, deliberate, cautious, almost slothful movements. The order of diminishing quickness of response, agility, and nimbleness for the anthropoid apes quite evidently is gibbon, siamang, chimpanzee, orang-outan, and gorilla. Yet if one should choose subjects without respect to age or environmental condition, one might readily upset this order, and even make it appear that the gorilla is more active than the gibbon! So here again what was emphasized in the previous section with reference to the inapplicability of any single description must be repeated.

Locomotion differs more or less radically in wild and captive specimens, particularly because of the opportunities afforded, but also because of changes in physique, adaptation to environmental opportunities or demands, and the acquisition of new habits, often in imitation of man or other associated creatures. Even more striking may be the contrast between the locomotor activities of the young, the mature, and the aged. With development, activity speedily diminishes and the creature becomes increasingly lethargic. There is, it seems, great difference in speed of reaction among the types of anthropoid ape. Both the gorilla and the orang-outan seem in general to be slower or more leisurely than the chimpanzee and gibbon. We have no observational basis for the assertion that the simple neuromuscular process differs temporally in these creatures, but the inference that it does is strongly suggested by such general descriptions as we shall quote and by our own observations of the daily life and behavior of captive specimens of approximately the same age.

An account of orang-outan locomotion should cover such general assemblages of acts as climbing, walking, sitting or resting, swimming, and use of the hands in throwing, reaching, or manipulating objects. Because of the superior quality of the Schlegel and Müller descriptions we shall depend primarily on them and shall freely translate or paraphrase their general account of climbing and walking.

> The manner in which the orang-outan climbs a tree or moves about in its crown entirely resembles in calmness and carefulness, as well as mode of using the limbs, the behavior of man. While with his long arms he embraces large trunks or grasps higher branches and pulls up his body, his feet serve for support and holding fast. Occasionally he may rest his weight for a time wholly upon the latter. This undoubtedly indicates great muscular power in the legs and feet. The free use of both hind limbs seems essential to climbing. In this respect the orang-outan differs markedly from the gibbon, which may swing itself freely through the trees by means of its arms alone. This method of climbing is quite foreign to the orang-outan, who seemingly lacks the courage to make even a little spring. In going from tree to tree the animal chooses a place where the branches approach closely to one another or touch. His prudent calmness, even in the greatest heat of pursuit, is wonderful. The sureness and careful consideration with which he goes to work are impressive. Slowly and carefully he moves himself on a great overhanging branch, lays himself flat upon it and stretches out as far as possible toward his objective, thus testing its strength and its ability to bend under his weight in the desired direction. Thus often he actually creates a bridge from tree to tree which is safely and conveniently used as a means of transit. From these facts it is clear that

the orang-outan, once discovered by the hunter and driven from his hiding place, cannot escape by speedy flight. But what he lacks in dexterity and quickness in climbing or jumping is in a

Fig. 46. A young female orang-outan resting in tree. Courtesy New York Zoölogical Society, E. R. Sanborn, photographer.

measure compensated by the cunning and caution with which he hides or conceals himself from view. In this indeed he finds his chief mode of escape from the pursuit of the hunter. (1839-44, p. 18.)

Strange though it may seem that a strictly arboreal primate should be so slow, cautious, and at times apparently even clumsy in the trees, the facts are well attested by all observers, and, moreover, the behavior of the animals on the ground as thus pictured by Schlegel and Müller is scarcely less surprising.

Less swiftly does the orang-outan move on the ground than in the trees. His walk, in which he always uses all four limbs, is somewhat tottering and it seems to cost great exertion. In speed it scarcely exceeds the usual walk of a man, and usually a man can outstrip the orang-outan. The great length of the arms, which as the creature walks or runs are held almost straight, raise the upper portion of the body considerably above the ground so that the creature's attitude resembles that of an old man who, bent under the burden of years, moves with curved back and a stick in hand. As the orang-outan walks the body is directed straight forward instead of obliquely as in some other apes. . . .

The orang-outan in walking on the ground does not place his feet flat on the surface but instead curves them inward so that he rests on the outer edge. The toes are clenched, and thus a part of the sole and the upper side of the first joint of the toes rest on the ground. The hands, on the contrary, are turned so that the inner edge is used chiefly as a support. The fingers are bent nearly outward, so that the first joint, especially that of the two inner fingers, rests with the upper side on the ground, while the free and erect standing thumb, with its tip down, serves as a counter support.

The preference for the upright position, which some writers assume in the orang-outan, is wholly and entirely lacking and the animals represented in this position, usually with a stick in their hands, are very unnatural. Ill-founded also is the opinion that the orang-outan can defend itself against man by using sticks, stones, and branches of trees. (1839-44, p. 19.)

As to the ability of the orang-outan to walk erect, Camper (1779, p. 61) long ago demonstrated to his satisfaction from observation of morphological characters, that it could not reasonably be expected to walk upright.

Following Camper, and perhaps influenced by his somewhat dogmatically phrased inference, Blumenbach (1810, p. 12) remarks of the orang-outan: "Both, this and the previous genus, supply the most obviously enlightening proof of the great gap which nature has established between man and ape: especially as the structure of the hind hands of these and all other Quadrumana prove the impossibility that any one of them could be adapted to naturally upright walking like man." Perhaps unintentionally Blumenbach reveals a motive for Camper's inference; namely, the desire to discover and establish beyond dispute distinctively human traits.

Pursuing the same subject historically and with facile exposition, Rennie (1838, pp. 91-92) informs us that both Abel (1818, pp. 322-323) and F. Cuvier (1811, pp. 189-190) declare

that it was utterly impossible for the orangs which they describe to maintain a perfectly erect attitude, and those which we have ourselves had an opportunity of observing showed no greater aptitude in conforming to this posture than a well-trained dancing-dog. All their motions, whether standing or attempting to walk upon the hind-legs, were constrained and awkward in the highest degree: they trod only on the external

1—5 Orang-Utan, 6—8 Gibbon.

Fig. 47. Characteristic postures and attitudes of young orang-outan and mature gibbon. From Brehm's *Tierleben,* 1922, p. 622. Bibliographisches Institut.

edge of the foot, whilst their long toes were invariably bent inwards along the sole, like a half-closed fist, or like the claws of the *sloths, ant-eaters,* and *pangolins;* their long arms were elevated over the head and waved from side to side, or occasionally touched the ground lightly, for the purpose of recovering the tottering equilibrium of the body, momentarily deranged by the vacillating and unnatural gait, and their pace was altogether slower and more difficult than the biped progression of many of the inferior simiæ. When obliged to move along a level surface, and left perfectly unconstrained, the orang-outan, like the chimpanzee and other apes, prefers walking on all-fours; but there is an essential difference in his mode of performing this action from what we have observed in the case of any other species. He does not tramp upon the whole sole of the foot like the chimpanzee, nor has he either the confidence or facility of that species in preserving an erect attitude. M. Geoffroy says that, first leaning upon the knuckles of the half-closed fore-hands, he raises both hind-legs at the same time, and projects the body forwards between the long arms; these, again, are advanced in their turn, to support the body in a new projection, and thus the progressive motion is performed by a series of successive swings, in all respects similar to the pace of a decrepit man moving upon crutches. It was too hasty a generalization of these facts, as observed in the orang-outan, that led M. Geoffroy St. Hilaire, and other naturalists, to attribute this mode of progression to the apes in general; the truth is, however, at least as far as our own observations extend, that it is entirely confined to individuals of the present species when in the last stages of disease, and that the weakness and constraint of motions are to be attributed to the sickly and debilitated condition of the individuals observed. Individuals in robust health never rest the entire weight of the body upon the anterior extremities; but, like all the other apes, walk upon the hind-legs, touching the ground occasionally on either side with the fore-hands, in order to preserve their equilibrium; and so necessary is this action, that even when held by one hand, the young orang is unable to walk upon the hind-feet without occasionally assisting its progress by resting upon the other.

By no means so cautious or so well informed, it would appear, as Rennie in the matter of orang-outan locomotion, Huxley (1863, p. 37), doubtless depending wholly on the observations of Schlegel and Müller, asserts without qualification that the "Orang never stands on its hind legs, and all the pictures, representing it as so doing, are as false as the assertion that it defends itself with sticks, and the like."

The experience of Wallace, although in the main confirming the observations of earlier authorities, supplements them significantly by indicating that it is not impossible for the orang-outan to stand erect.

Once only I saw two half-grown Orangs on the ground in a dry hollow at the foot of the Simūnjon hill. They were playing together, standing erect, and grasping each other by the arms. It may be safely stated, however, that the Orang never walks erect, unless when using its hands to support itself by branches overhead or when attacked. Representations of its walking with a stick are entirely imaginary. (Wallace, 1869, I, 94.)

Hornaday, from his experience in Borneo, offers the following pertinent and valuable description.

Upon the ground the orang is a picture of abject helplessness. In his native forests he is very seldom known to descend to the earth, and so far as my experience goes, I have never seen nor heard of a single instance of the kind. True, he climbs down when thirsty until he can reach the water with his hands, but this occurs where there is no dry land to walk upon.

The orang-utan is utterly incapable of standing fully erect without touching the ground with its hands. I have seen many orangs in captivity, but not one of them ever stood erect upon its hind legs for a single instant, and for orangs to be so represented in drawings or museums is contrary to nature. (Hornaday, 1885, p. 404.)

Whereas Schlegel and Müller, Wallace, and Hornaday observed mature or immature animals in their natural habitat and based their descriptions of locomotion on the behavior of such individuals, the other authorities cited draw their data in the main from anatomical specimens or living captives. It would not be in the least surprising if the captive orang should, through imitation or otherwise, acquire the ability to stand and walk erect. There are indeed, as we shall now attempt to indicate by citation of authorities, many indications that this actually occurs and that the seeming contradictoriness of the statements concerning walking offered by different authorities is due in part, if not wholly, to difference in environment and possibly also in age, for it would seem likely that immature specimens would more readily learn

to walk upright than would adults. From the experience of Sokolowsky the follow-

Fig. 48. Erect attitude of orang-outan, showing characteristic position of feet and arms. Courtesy of F. W. Bond, photographer, and Zoölogical Society of London.

ing evidence, contradictory of the tenor of the descriptions offered above, is drawn.

Both the large orangs of the Hagenbeck park ran upright without being induced to do so. The male specimen had accustomed himself to crossing his arms when walking upright. It looked truly comical to see the orang walking around in his waddling way with his arms folded. The animals are, moreover, very tame and wholly reliable, so that one can walk with them while holding their hands. . . . It always gave me special joy to take a short walk with one of the orangs. The apes weary, however, very easily in this upright position, as can be easily understood if one remembers that the animals walk, with the feet turned inwards, upon the outer border of the foot. (Sokolowsky, 1908, p. 62.)

There are numerous reports to the same effect as Sokolowsky's, and from our own experience with three immature and one mature orang we can confirm the statement that it may on occasion stand and walk erect, usually with feet curved inward and the weight of the body resting chiefly on the outer edge of the foot. The arms may be held at varying heights and in varying degrees of straightness, above the head or in other positions, depending presumably upon the habit resulting from the posture assumed during the initial stages of learning to walk. We agree with the earlier authorities that it is extremely difficult and fatiguing for the animal to walk erect and that ordinarily it will do so only for a short time and over a small distance unless under compulsion.

Fig. 49. Erect attitude of orang-outan. A female about six years old. Courtesy of A. S. Le Souef.

Of the resting or sitting attitude of this great ape Hornaday remarks, "The orang never sits down as do the gibbons and

therefore it has no ischial callosities like the Hylobates." (1879, p. 441.) Although this author's statement may be essentially correct it is misleading because of its incompleteness, for we learn from Schlegel and Müller, as well as from other naturalists who have had ample opportunity to observe free specimens, that orang-outans resting quietly in the trees of their native forests assume a sitting attitude. It seems, however, that their weight rests partly on the legs and seldom if ever wholly, as in case of the gibbon and many other primates, on the ischial regions. The pertinent description of Schlegel and Müller may be freely rendered as follows:

> The ischial regions of the orang-outan are unsuited because of their thin covering of flesh and the conformation of the underlying bony structure to serve as points of support for the orang-outan's heavy body. This obliges the animal to crouch down, using the legs as support for the arms, so that the latter are always free from the ground and the animal when sitting upright rests entirely upon its hind limbs. (1839-44, p. 17.)

It is generally agreed that the orang-outan does not trust itself to the air. It seldom if ever springs or jumps and it ordinarily is reluctant to move by means of its arms alone. With these characteristics or peculiarities in mind, it is interesting to inquire whether it exhibits any locomotor skill in water. Unhappily, the available information is scanty and otherwise unsatisfactory, since no systematic inquiry has been made. We cite, herewith, the only observations which we have found recorded.

Quoting a traveling naturalist, by name Labillardiere, Audebert (1800, p. 19) remarks that the Jocko does not swim, for it had been reported to him that an animal of this species which fell into the water made no attempt to save itself but instead sank quite tranquilly and would have perished had no one come to the rescue. Jocko in this case certainly refers to the orang-outan.

Strikingly similar to the brief report of Audebert is the following from the experience of Hornaday (1885, p. 419):

> Late in the evening, when I went down to the creek to bathe, I took the little mias along to see if he could swim. I gave him a perfectly fair chance, for instead of pitching him plump into the water as we do dogs and puppies I waded with him in my arms out to where the water was waist deep, and then poising him on the surface let him go, much against his will. Did he swim? Hardly. He turned heels up in an instant and his old head went down as if it had been filled with lead instead of brains. Instead of striking out vigorously with his arms and legs as other animals do, those useful members simply stuck straight out from his body like four sticks and moved slowly and feebly, first one way and then another, as the old fellow sank to the bottom. I waited a moment to see if he would, in any measure, recover himself, or come to the surface, but he only turned horizontally in the water and remained a foot below the surface, stiff and helpless. I waited until it would have been cruelty to have left him longer, and then, like Pharaoh's daughter, I drew him out. He did not whine or scream, but you should have seen his face. Its expression of injured innocence and disgust at the whole business spoke as plainly as words.

Referring to what was a mature animal, as contrasted perhaps with those mentioned by Audebert and Hornaday, Garner reports:

> A gentleman of my acquaintance assured me recently that during his sojourn of two years in the Island of Sumatra, he had in his service a large orang. This ape did many chores about the place, and performed many simple duties as well as the other domestics did.
>
> On one occasion, this ape was induced to go aboard a steamer which lay in the harbour. The purpose was to kidnap him and carry him to Europe. Either through fear, instinct, reason, or some other cause, this ape jumped overboard and swam ashore, although he was naturally afraid of water. From that time on to the end of the gentleman's residence there, he assures me that whenever a steamer made its appearance in the harbour, the ape would take flight to the forest, where he would stay as long as the vessel remained in sight. He was seen from time to time, but could not be induced to return to the house until the vessel had departed. (1892, pp. 165-166.)

Confirmation of the statement that the young orang-outan is unable to swim is offered by Shelford (1916, p. 5) and Furness (1916, p. 284). The latter explicitly states that he carried a tame specimen which was thoroughly familiar with him into the water of a swimming pool. The animal exhibited

fright and as the water came up about its legs became panic-stricken.

We may not conclude from the evidence available that the orang-outan is unable to

Fig. 50. Young orang-outans at play.

swim, but tentatively it may be inferred that both young and adult dislike the water, tend to avoid entering it, and swim if at all only on compulsion.

The use of hands and feet by the orang-outan in climbing and walking has already been described. The greater part of our information, reproduced by numerous summarists and compilers, we owe to Schlegel and Müller. Both hands and feet are used readily and skilfully for grasping branches or tree trunks in climbing, and they may on occasion be used interchangeably for the manipulation of objects. The hand is referred to by Hornaday (1879, p. 440) as naturally closed and difficult to straighten after the death of the animal.

That preferential use of hand and arm or foot and leg appears is uncertain. Deniker (1882, p. 340) mentions an adult male which obviously preferred to reach with the left hand; and referring to a captive adult male which lived only a few weeks after the observation, Fick (1895, p. 6) notes that in grasping objects he seemed most skilful with his right hand and apparently preferred it, so that he may be considered right-handed, "as indeed most apes are." Whether the general statement hazarded by Fick is correct we seriously doubt. Indeed, from our own observation we may cite a case of left-handedness, in support of that of Deniker. The specimen was a young male orang-outan, and the preference for the left hand was observed during an experimental study of the animal's behavior which covered several months.

Mollison, who has made important studies of bodily proportions and structural asymmetry in their relations to the preferential use of extremities in the primates, asserts that the right upper extremity is strongly preferred by gibbon, orang-outan, and man (1908, 1910-11).

Evidently we may not conclude from these data that orang-outans are predominantly either left- or right-handed. Nevertheless, it is reasonably certain that preference for the one or the other hand is manifested.

The extremely long arm of the orang-outan, with its useful terminal member, is habitually employed in gathering food in the forests. It has the very great advantage of enabling the animal to reach afar and thus take buds or fruits from branches which are too light to hold its weight. Whether the orang-outan ever throws objects defensively or offensively is in doubt because of the contradictory statements of authorities. Schlegel and Müller, as already quoted (p. 113), are of the opinion that it does not defend itself against man by using sticks, stones, or branches.

Brooke also (1841, p. 58) asserts that the branches which fall from the trees when the animals are being hunted are broken by their weight instead of being thrown at pursuers. But an entirely different account of defensive behavior is offered by Wallace (1856a, p. 27), who states that the orang-outan

> never jumps or springs, or even appears to hurry himself, and yet moves as quickly as a man can run along the ground beneath. When pursued or attacked, his object is to get to the loftiest tree near; he then climbs rapidly to the higher branches, breaking off quantities of the smaller boughs, apparently for the purpose of frightening

his pursuers. Temminck [1835-41, p. 385] denies that the Orang breaks the branches to throw down when pursued; but I have myself several times observed it. It is true he does not throw them *at* a person, but casts them down vertically; for it is evident that a bough cannot be thrown to any distance from the top of a lofty tree. In one case, a female Mias, on a durian tree, kept up for at least ten minutes a continuous shower of branches and of the heavy spined fruits, as large as 32-pounders, which most effectually kept us clear of the tree she was on. She could be seen breaking them off and throwing them down with every appearance of rage, uttering at intervals a loud pumping grunt, and evidently meaning mischief.

What, then, may be our conclusion in this matter? Obviously there is no excuse for dogmatism, but on the basis of careful comparison of available records and our own observations we affirm that the adult orang-outan may on occasion throw objects defensively. Whether such behavior is common in the species, or restricted to exceptional individuals, we do not know. Of captive individuals it is entirely safe to predicate ability to manipulate objects with their hands and to throw them as they may desire, for in many instances captivity supplies exceptional opportunities, incentives, and aids, notable among which are the imitative copy provided by man, and occasionally also his tuitional efforts.

NEST BUILDING AND SLEEPING

Early mention of nesting or nest-building behavior in the orang-outan is found in the writings of Vosmaer (1778), Daubenton (1782-1825), White (1799), and others, but in no instance is evidence given of definite and assured knowledge of the phenomena. Moreover, in most instances, as in that quoted below from Vosmaer, the reference is to captive individuals. Referring to a female which he had opportunity to study for several weeks in Europe during 1776, Vosmaer (1778, p. 16, free and condensed translation) writes:

At the approach of night she went to bed; and the preparations which she was seen to make were even more remarkable than her manner of eating and drinking. She never slept voluntarily in her quarters, for fear, it was thought, of being shut in. When she wished to lie down, she arranged the hay in her litter, shook it well, stretched it out to make a pillow, placed herself usually on her side, and covered herself well, being very sensitive to cold. . . . From time to time they observed her doing something which surprised them extremely, especially the first time they witnessed it. Having prepared her couch as usual, she took a strip of linen which happened to be near her, stretched it neatly on the floor, put some hay in the center of it, and folding the four corners on top of it, carried it back with great care to her bed for a pillow, then pulled the covers over her. During the day she slept at intervals, but never for very long.

Since Schlegel and Müller were the first scientists to describe circumstantially and with obvious care and ample data the nesting and sleeping habits of the orang-outan, we shall take our general description from them and shall use other authorities to supplement it.

Probably because it is there too windy and too cold for him, the orang-outan seldom passes the night in the crown of a large tree. As twilight approaches he descends from the heights and seeks a resting place in the thick-leaved top of a small tree. In the selected spot he gathers together branches and leaves which he arranges so that they constitute a smooth supporting structure. In one region several fresh nests were observed at heights of ten to twenty-five feet above the ground. They were two to three feet in diameter and round. Some were heaped several inches high with leaves and others contained only small broken branches and twigs. According to the report of the Dyaks the orang-outan seldom leaves his night's resting place before the sun has risen and the mists disappeared. It seems that the characteristic sleeping attitude is on the back or side with the legs drawn close to the body while the hands either support the head or are folded across the body. In cold, windy, or rainy weather the animal sometimes covers himself with leaves or branches. This doubtless has given rise to the report that he builds "huts" in the trees, a myth, which should be classed with the wonderful fables used by travelers to adorn their tales. (Schlegel and Müller, 1839-44, p. 15.)

The somewhat prolix and diffuse description offered by these authors is admirably condensed, and at the same time rendered in a delightful style in the French, by Temminck (1835-41, pp. 379-380).

Noteworthy contributions to this topic, of the same period as those of Schlegel and

Müller and Temminck, are the works of Rennie, Martin, and Brooke. Lacking other information about nest construction Rennie (1838, p. 100) recounts the observations of Vosmaer, while Martin (1841, p. 399) asserts that the animal does not build huts, "but, in accordance with its arboreal predilections, it constructs arbours among the top branches of the highest trees, with a covering of leaves and twigs, in which it takes up its abode." Fortunate in opportunity for direct observation, Brooke confirms the fact of nest construction, but criticizes adversely the use of the term hut because in his experience the structure has no roof-like covering (1841, p. 58).

The observations of Wallace, who describes especially the protective nest-building behavior of wounded orang-outans, significantly supplement those of Schlegel and Müller. He also confirms in all essentials their account of nesting and sleeping activities.

As soon as he feels himself badly wounded he makes a nest which, if he completes, is so secure that he will never fall from it. I lost two Miases that way, both dying on their nest. . . . (Wallace, 1856a, p. 27.)

A large male orang-outan which was being pursued after being wounded took refuge in the top of a high tree.

I fired again; and we then saw that one arm was broken. He had now reached the very highest part of an immense tree, and immediately began breaking off boughs all around, and laying them across and across to make a nest. It was very interesting to see how well he had chosen his place, and how rapidly he stretched out his unwounded arm in every direction, breaking off good-sized boughs with the greatest ease, and laying them back across each other, so that in a few minutes he had formed a compact mass of foliage, which entirely concealed him from our sight. He was evidently going to pass the night here, and would probably get away early the next morning, if not wounded too severely. (Wallace, 1869, I, 79.)

Contrasting the protective nest construction of the orang-outan with the sleeping nest, Wallace states that the latter usually is placed on a small tree and not more than twenty to fifty feet from the ground.

Probably because it is warmer and less exposed to wind than higher up. Each Mias is said to make a fresh one for himself every night; but I should think that is hardly probable, or their remains would be much more abundant; for though I saw several about the coal-mines, there must have been many Orangs about every day, and in a year their deserted nests would become very numerous. The Dyaks say that, when it is very wet, the Mias covers himself over with leaves of pandanus, or large ferns, which has perhaps led to the story of his making a hut in the trees. (Wallace, 1869, I, 92-93.)

Following in the naturalistic footsteps of Wallace, Hornaday also observed nesting behavior and thus concisely describes it:

The nest of the orang-utan consists of a quantity of leafy branches broken off and piled loosely into the fork of a tree. He usually selects a small tree, a sapling in fact, and builds his nest in its top, even though his weight causes it to sway alarmingly. He always builds his nest low down, often within twenty-five feet of the ground, and seldom higher than forty feet. Sometimes it is fully three feet in diameter, but usually not more than two, and quite flat on the top. There is no weaving together of branches, for they are merely piled crosswise as a natural consequence of their being broken off on different sides of the nest. In short, the orang builds a nest precisely as a man would build one for himself were he obliged to pass a night in a treetop and had neither axe nor knife to cut branches. I have seen one or two such nests of *men* in the forest where the builder had only his bare hands with which to work, and they were just as rudely constructed, of just such materials and in about the same general position, as the average orang nest. Upon this leafy platform the orang lies prone upon his back with his long arms and short, thick legs thrust outward and upward, firmly grasping while he sleeps the nearest large branches within his reach. On several occasions I surprised individuals upon their nests, and once I had an opportunity to watch an orang while it constructed its resting-place.

During one day's travel along the Upper Simujan river we counted thirty-six old nests and six which we set down as new, or fresh. I have never been able to ascertain to a certainty, but it is my opinion that an orang after building a nest sleeps in it several nights in succession, unless he is called upon to leave its neighborhood altogether. Certain it is that whenever a hunter finds a perfectly fresh nest he may with confidence expect to find the builder somewhere near it. An orang never uses a nest after the leaves become withered and dry, no doubt for the reason that the bare branches afford an uncomfortable resting-place. I never saw nor heard of any house-building by

orang-outangs, though I am led to believe that some individuals may have a habit of covering their bodies with branches for protection against the dashing of the rain-drops during a heavy storm. My little pet orang would invariably cover his head and body with straw or loose clothing the moment it began to rain, even though he was under a roof all the time. (Hornaday, 1879, pp. 445-446.)

In the main, Hornaday's observations as reported in his publications of 1879 and 1885 essentially confirm the accounts of Schlegel and Müller, Temminck, and Wallace. But in his description of a sleeping specimen he adds to the recorded information.

Half way down the lake we discovered a fine old orang, lazily finishing his morning nap. His nest, which was nearly three feet across, was not more than fifteen feet above the water, and he lay sprawled out upon it, flat on his back, with the sun at the back of his head, sound asleep. His hairy arms and legs were thrust outward and upward, and his hands (an orang has hands on his legs, if you please) were firmly but mechanically grasping the largest branches while he slept. The back of his head was toward us, and, after silently paddling up to within fifteen yards of him, I stood in the boat to observe and afterward to make a rough sketch of him on the inside of an envelope.

While we were watching him, he snored almost continuously, "not loud, but deep," until presently the flies bothered him and he awoke. With a slow, awkward sweep of his ponderous right arm he drove the flies from his face, and a moment later was wide awake. (Hornaday, 1885, pp. 393-394.)

The snoring of the animal mentioned by Hornaday is confirmed by the reports of other reliable investigators, and although it may not be a common phenomenon, neither does it appear to be rare or exceptional.

Unique in the literature of nest construction, and, therefore, especially worthy of quotation, is the following description of the process as observed by Schneider and reported by Sokolowsky.

The trees with orang nests usually stand on slopes, especially in places hard to approach, chiefly in extensive swamps. The water reached far over my knees. The nest itself resembled in form and size a stork's nest. It is a resting place made of twigs laid over one another and loosely bound together. Thin twigs with many leaves lay in the centre. The nest was cushioned with leaves. The orang does not break off the branches of the tree which are nearest to the nest, but he interlaces suitable ones and uses therefor only the ends of the twigs and those which he can easily bend to make a natural evergreen covering. By means of this dome-shaped covering he knows how to withdraw himself wholly from undesired observation.

Shortly before approaching darkness (15 minutes before six o'clock evening) the orang begins to erect his nest. He stands upright, yet in a bowed natural position, on a forked branch. The left arm he uses as a support, while with the right hand he draws in distant branches, breaks them then with his hand and piles them up crosswise and diagonally behind himself and at the side, until he is surrounded by a whole circle of broken twigs, to the height of 45 cm. and more. When this is done, the orang begins the construction of the floor, by breaking off smaller twigs and laying them all in the middle of the nest. After the form of the nest is completed, he cushions it. For this purpose he seizes long twigs of the tree as far behind him as possible and runs his half-closed hand the length of the twig, so that all the leaves are stripped off and fall directly into the nest or are gathered partly in his hand. If the latter is the case, he throws them into a certain place in the nest and presses them down with his closed hand into the crevices. Then the orang lies half on his side, draws together over all the fine twigs which had been left standing and interlaces them with the nest, so that the above mentioned dome-like roof is formed. Here and there he breaks off yet a few twigs and lays them up on himself so that he is completely covered by them. This he probably does to protect himself against the heavy dew fall and the cold of the night. (Sokolowsky, 1915, p. 621.)

This constructional process is said by Schneider, who observed it watch in hand, to have required thirty minutes. Whether the process of roof construction so circumstantially described, the like of which is confirmed by certain authorities and denied by others, is exceptional we have no means of telling. We should naturally expect from the body of published information on the subject, and from our own experience, that individual differences in nesting and sleeping behavior would be common and extreme.

General accounts of nesting behavior are offered by Sokolowsky, Shelford, and Heck. The only systematic comparative discussion of anthropoid nest building is that of

Sokolowsky (1915), while Shelford, a naturalistic observer, offers the following as contribution to our knowledge of the behavior of wild and captive specimens. We quote the description at length chiefly because of the latter.

> When the Maias goes to rest, it lies flat on its back on its nest and holds like grim death with hands and feet to the branches in the fork of which the nest lies; and so it passes the night, half supported by the frail platform, half suspended by the hands and feet, whose grip is secure even in the deepest slumber. A young Maias that I kept as a pet for many months always slept in an empty room in my house; the only article of furniture in this room was an iron bedstead, and on to the steel laths of this the ape would solemnly climb every evening at about 6.30; he invariably sprawled on the flat of his back, pulled over his head and chest a piece of sacking with which he was provided, and with hands and feet got a good grip on the posts or frame of the bed. In a few minutes he would be asleep, and his snoring was so loud that it could be heard nearly all over the house.
>
> If, in the daytime, this young ape desired to rest in a tree, he would construct a rough attempt at a platform, and lie on this, hanging to the branches with hands and feet and swinging in the breeze for an hour or so at a time. It is easy now to account for the fact that the Maias makes its sleeping quarters amongst slender branches in the tree-tops; if the nest were made in the fork of some huge bough the ape would have nothing to grasp when asleep. . . . The natives assert that the female Maias, when about to give birth to a young one, makes a very large platform amongst big branches and stays on it for several days; but I cannot vouch for the truth of this statement. (Shelford, 1916, pp. 3-4.)

In addition to characteristically readable and reliable general account of the nest-building and sleeping activities of the orang-outan, Heck offers evidence confirmatory of the reports of Vosmaer (1778), Abel (1818), Fick (1895), and others that captive specimens very commonly try to construct for themselves nests as resting and sleeping places. Several instances are noted by Heck in which orang-outans captive in zoölogical gardens have constructed tree nests. He is inclined to interpret the behavior as primarily "instinctive," since it seemingly appears when there has been little if any opportunity for observation by the individual of the process of nest construction, and when, furthermore, there is no need of a nest for protection or as a resting place (1922, p. 636).

The evidence is conclusive that nest building is a characteristic orang-outan activity; that the construction may be used either as a protection, or as resting place; that there is wide variation in mode of locating and building of nests, as well, naturally, as in the materials utilized; that the orang-outan when of nest-building and nest-using age regularly occupies the nest as a bed, lying on back or side in human fashion instead of sitting up more or less erect as does the gibbon; and that snoring occurs. There are no data for safe statement regarding the relation of age or developmental status to nest construction or utilization, nor is it clear whether males, females, or both, regularly construct nests. Whether the behavior is primarily instinctive is not known.

FOODS AND FEEDING BEHAVIOR

In nature the orang-outan is a vegetarian, whose chief articles of diet are certain of the fruits, buds, blossoms, leaves, stems, shoots, and barks indigenous to Borneo and Sumatra. This general statement we base upon the observations of Schlegel and Müller, Wallace, and Hornaday. There are, to be sure, many secondary sources of information, the data of which often are drawn from one or all of the above-mentioned authorities, and there are also many more recent statements confirmatory of those which are obviously authoritative and prior. According to Hornaday (1879, p. 441) the teeth are often stained black at the base by certain vegetable juices.

The literature provides no adequate account of the feeding behavior of this ape in nature, and even fragmentary observations are rare. It, therefore, is impossible to do more than indicate the nature of the diet and to infer from existing meager accounts of the daily life of the orang-outan that it feeds exclusively during the day and chiefly in trees instead of on the ground. Ample

evidence is furnished by Schlegel and Müller (1839-44, p. 20) and Hornaday (1879, pp. 444-445) that migration is controlled by food supply and that the animals regularly, and presumably habitually, seek certain regions in correspondence with the ripening of locally distributed fruits. Migration, however, is primarily a social phenomenon and we may more appropriately describe it in a later chapter.

Aside from the references already cited, the facts concerning food and feeding which the literature provides are based on observation of captive animals, and although this information is not strictly relevant to the natural history of the animal, it still is of so great practical importance and so essential to the formulation of problems and the shaping of conditions for experimental work that it may appropriately be presented in this connection. It is of first importance, however, that the contrast between the diet and feeding habits of free and captive animals be emphasized. As a matter of fact, we are almost totally ignorant of the features of feeding behavior which are characteristic of species, sex, and stage of development, and consequently unable to distinguish such primary racial modes of response from individually acquired or adventitious forms of activity. With this warning as to the possible and probable contrast between free and captive feeding activities, we shall cite from the literature certain significant, although fragmentary, accounts of the behavior of captives.

It is commonly recognized that immature specimens may much more readily be taught to eat in captivity than may mature or old individuals. The latter, indeed, not infrequently refuse food and either starve themselves to death or so weaken themselves that they readily succumb to disease. Referring to the experience of native hunters, Schlegel and Müller report that when they have taken the young orang-outan alive they try to feed it on cooked rice, sugar cane, bananas, and other fruits and vegetables (Schlegel and Müller, 1839-44, p. 23). Of an infant specimen which came into the possession of Wallace when, according to estimate, about a month old, the author says that it was fed on rice-water until old enough to take soaked biscuit, egg, sweet potato, and other solids (1856, pp. 386 ff.).

Sometimes it is difficult to get even the young captive orang-outan to take food. The following experience reported by Hornaday is of peculiar interest and practical importance.

> For a long time he would eat nothing but bananas and sugar-cane, and I was at my wits' end to find a way to teach him to eat boiled rice. One day, however, as he was sitting in my lap while I was at dinner, I noticed that his eyes followed the journeys of my spoon with great interest, and it occurred to me that human beings always want what they cannot have. Happy thought! I began to pass each spoonful of rice close to his mouth on its way to mine. He soon began to open his mouth every time he saw the spoon coming, only to be disappointed by seeing it travel on to his next neighbor. From being merely willing to try the rice, he became very anxious when he saw it was denied him, and a little more tantalizing set him to struggling violently for the food he had previously despised. When it was finally given him he ate it with the greatest satisfaction, and thereafter, with the addition of milk, it became his daily food.
>
> He also learned to eat with relish all kinds of cooked meat, vegetables, canned fruit and bread, and to drink tea, coffee, milk and chocolate, in all respects evincing the tastes of a human being—except that he would not touch beer, wine, nor spirits. He lived and died a teetotaler. (Hornaday, 1885, pp. 382-383.)

Contributing also to the often extremely baffling problem of inducing the captive to take food is the following statement of Mayer:

> If food is pressed at once on a captured orang, nine times out of ten it will refuse to eat, will continue to refuse and will mope. But if it is allowed to get really hungry and is then offered food, it will eat and cheer up. (1923, p. 667.)

Our experience with the great apes entirely agrees with that of Hornaday and Mayer, and we have no hesitation in saying that success in feeding a captive orang-outan depends far more on the knowledge, insight, patience, and skill of the care-

taker-observer than on the individuality of the specimen. It is essential to establish and maintain friendly relationship between captive and caretaker, to stimulate imitative action, and above all to avoid so far antagonizing the subject as to induce an attitude of negativism. Immature specimens are much more willing to try new things, in a word they are more docile than are adults, but the advice implied in the statements of Hornaday and Mayer is widely applicable in the treatment of captive orang-outans.

That feeding behavior is highly subject to adaptive modification is entirely clear from the numerous and varied accounts of the daily life of captive specimens. One of the earliest useful records is that of Vosmaer, who, in describing the food and feeding of a well-grown female captive, says:

> She ate nearly everything that was given to her. Her ordinary diet consisted of bread, roots, especially the yellow carrot, all sorts of fruits, especially strawberries, but she seemed very partial to aromatic plants such as parsley and its roots. She also ate boiled or roasted meats and fish. She was never seen to hunt for insects, of which other species of monkeys are so fond. One time when she was given a large spider and a fly, she crushed them between her teeth as though to taste them, but expelled them at once. (1778, p. 15, free translation.)

This evidently is a case of extreme sophistication or domestication with respect to dietary adaptation, and it well shows what can readily be done toward adjusting the captive to the human food supply.

Although Vosmaer reports the eating of cooked meats and fish, it is reasonably certain from varied evidence that the free animal does not ordinarily eat animal products. On this point Schlegel and Müller (1839-44, p. 20) report that according to the stories of the Dyaks the orang-outan in nature seldom eats any animal product, and the authors further say that the tastes of newly captured individuals seem to confirm the opinion of the natives.

> Many times we have laid before a captive in his cage living fowls, as well as raw and cooked fowls and other winged animals, without having him touch or exhibit the least desire for such food, and when a living creature came so close to the orang-outan that it inconvenienced him he would push or throw it aside impatiently with one of his hands. Possibly the orang-outan in lean times may make use of insects and their larvae, the eggs of birds, and shell fish, but the fact is not established.

Enlightening also are the statements made by Fick concerning the foods of captive adult or old orang-outans:

> With regard to the method of nourishment of the orang, all three of these grown specimens which have come recently to Europe, in spite of their mighty canine teeth, were strict vegetarians. They even refused doves which . . . were placed before them experimentally in all stages of age. Eggs alone of animal nourishment were accepted. (Fick, 1895, p. 5.)

From much practical experience in handling captive orang-outans Sokolowsky concludes that whatever they may be fed in captivity it is possible thoroughly to accustom them to the usual human diet. He recommends as chief dietary articles: milk, bread, soft fruits, vegetables, soups, and meats. Fish, he says, may be eaten willingly (Sokolowsky, 1908, pp. 56-57). And Yerkes (1925, pp. 211 ff.), in describing the care of orang-outans and other anthropoid apes in the Abreu primate colony, similarly indicates that a varied diet not unlike that of man is satisfactory.

The manner of eating among captive specimens varies considerably. There are no scientifically valuable descriptions, but typical of such information as the literature supplies are the following. As naturalist in Borneo, Shelford notes that orang-outans

> are very sedate and deliberate in their movements, even when feeding. If presented with a fruit or some other article of food that is new to its experience, the Maias will carefully scrutinize and smell the morsel, a small bite will be taken, and the fragment of food will be rolled round and round inside the mouth; then the lower lip will be shot out to its utmost extent with the piece of food on it, and the ape will squint down his nose in the most ludicrous manner, as if to see how the food is getting on during the process of mastication. (Shelford, 1916, p. 5.)

Just such behavior we have frequently

observed in a captive young orang-outan which was for months the subject of systematic study.

Contrasting sharply with the picture of the feeding orang-outan drawn by Shelford is the following from Warwick (1832, p. 307):

> Food, on the other hand, was the only object that would cause any attachment, or even locomotion, in the female [orang-outan]; of whom it might be said, that her appetite was the mainspring of all her actions, to which a protuberance and rotundity bore ample testimony. In feeding, the greediness of the female was evinced by her laying her body over the dish, securing the choicest morsels both with hands and feet, and then feeding with her mouth in the dish, using her lips in the manner of the horse, and evincing the greatest fear lest any portion should be taken from her.

One may very well credit these authors with accuracy, for the feeding behavior of a captive ape is well known to depend upon such circumstances of captive existence as the treatment received from humans and the characteristics of its animal companions.

Our main conclusions from critical comparative examination of the pertinent literature are: That the orang-outan in dietary requirements and feeding behavior is, like man, extremely adaptable, and therefore capable of subsisting on an indefinitely varied diet and on extremely differing combinations of foods; also of adapting its mode of feeding or habitual activities to the most varied conditions and circumstances. Naturally a vegetarian, this ape may become accustomed to animal food products and may even come to prefer them to what is ordinarily the natural supply. In general, specimens captured during infancy or childhood readily adapt themselves to human dietary requirements. The older the individual when captured, the more difficult it is to induce it to take food in captivity and the less adaptive it is so far as food supplies and feeding habits are in question. Like man, the orang-outan, given favorable conditions, learns to eat what is available and acquires whatever modes of activity are essential. In these adaptive processes the physique and social environment of the individual are of extreme importance, and it may readily be demonstrated that both what and how the individual eats are intimately related to and dependent upon factors of health, strength, companionship, and docility.

We assume that there is something fundamental, primary, and native, by way of feeding response, which on the development of hunger induces activity that according to circumstances proves either serviceable or the opposite. Formerly we should have characterized this response as instinctive, and we probably should have thought of the orang-outan's feeding behavior as chiefly determined by instinct. Now, on the contrary, we are reasonably clear and assured that the complex and varied behavior which is observed in any captive specimen, or which may be observed presumably in wild specimens under suitable conditions, is the elaboration, modification, and adaptation of the primary nutrition-seeking activity. In other words, the total feeding behavior of the organism is essentially a habit system. How little the existing literature on orang-outan behavior contributes to thoroughgoing knowledge and understanding of this subject we have tried to indicate by our method of exposition. Not only are we still on the descriptive level of work, but we may fairly and even with liberality of view say but little progress has as yet been made toward adequate description even of such obviously fundamental behavior complexes as those of feeding.

Turning now from foods to drinks, and from eating to drinking habits, we immediately discover that although water is the natural drink of the orang-outan, captive specimens may with more or less ease and facility be induced to take milk, tea, coffee, cocoa, or alcoholic drinks.

The manner of drinking varies no less than does the manner of eating. Presumably it is a case of individual preference or of convenience in a given situation.

> If water is offered to the orang when he is

thirsty he opens his mouth, but instead of receiving the fluid at once within his teeth, he protrudes his under lip an inch or two beyond the teeth, pursing the integuments into a kind of hollow or cup, where he receives the water, and whence he draws it into the mouth proper. (Grant, 1828, p. 5.)

Additional facts are supplied by Schlegel and Müller, who, in commenting on the use of the lips in eating and drinking, state that food which is somewhat strange to the orang-outan is usually examined with lips and hands, pressed against the lips and tested before being taken into the mouth.

> The underlip, moreover, plays an important rôle in the drinking of liquids. Whereas Hylobates with open mouth receives the raindrops, or quenches his thirst by using his naturally curved hands which he dips in the water and afterwards holds above his outwardly directed mouth, the orang-outan uses, for the same purpose, only his lips. If he is thirsty and it begins to rain, he sticks out his underlip in the shape of a great ladle, two thumbs in front of it, and catches as much rain water as he needs. Of this peculiar mode of using the underlip as a sort of cup, our large wild orang-outan made use whenever he was thirsty. . . . Yet if one filled with water a half shell of cocoanut which was kept in his cage as a drinking vessel, he would take up the shell with truly human readiness with one of his hands and would pour the water into his extended and cup-shaped underlip, from which it was sucked into the mouth. The young orang-outans drank in another way when a dish or basin of water was placed before them. They drew the lips into funnel-shape, placed the point of the funnel under the surface of the liquid, and sucked it through the rounded opening. If circumstances did not permit the use of this method they sometimes used their hands to advantage, dipping and licking off the drops with their lips. (Schlegel and Müller, 1839-44, pp. 27-28.)

The following description from Hornaday (1885, p. 367) of the act of drinking as observed in a free wild orang-outan is of unusual value.

> A little farther down we surprised an orang in the act of taking a drink. He had climbed down within reach of the water and hung at the foot of a stout sapling, dipping one hand into the water, then holding it over his mouth and sucking the water off as it dripped from the knuckles of his closed fingers. He was so busily engaged that I got a good look at him with the glass before he saw us.

Brief comparison of manner of drinking in orang-outan and gibbon is supplied by Shelford (1916, p. 8):

> I found it very interesting to compare the methods of drinking adopted by the Maias, the Gibbon, . . . The first, if offered drink in a bowl placed on the ground before it, will generally bend down and drink out of the bowl without handling it. . . . The Gibbon dips one hand into the bowl and then, throwing the head back, sucks the moisture off the hair on the back of the hand; it is a very characteristic action, and it is repeated again and again until the thirst is satisfied.

Again, individual differences are emphasized, for it is well attested that captive orang-outans may drink directly from vessels either by bending their faces to them or by taking them up in their hands and holding them in human fashion. There is inevitably, because of the structural peculiarities of the lips, a tendency for this ape to use the funnel formation of the lips to suck the water into its mouth instead of lifting the vessel and pouring the liquid directly into the mouth, as do man, chimpanzee, and gorilla.

Records apparently justify the tentative conclusion that the orang-outan habitually drinks water in nature, taking it according to convenience and individual habit or whim by applying the lips to the surface and sucking up the liquid, by protruding the lower lip and allowing the rain water to fall directly into the cup-shaped cavity thus formed, by dipping the hand into water and then holding it above the mouth to allow the drops to fall into the protruded lower lip, or by licking or sucking moisture somewhat as does the gibbon from the hand or arm. There is then very considerable variety in method of drinking, and as will appear from later comparison, the orang-outan seems in respect to its drinking behavior to stand between the gibbon and the chimpanzee, the former being least like man in respect to this activity of all the anthropoid apes, and the latter perhaps most nearly human.

Some at least of the activities which have been described in previous para-

graphs would by many biologists be designated as instinctive. There is no necessity in this connection to quarrel over terminology, but we are interested in the fact that the term instinct occurs infrequently in the literature on the orang-outan. As was suggested in an earlier paragraph, we see good reason for avoiding the use of the word in this work. It has among other things acquired connotation which we deem improper, since it is now possible to demonstrate that many activities formerly called instinctive are in large part the product of elaborative modification of behavior which finally results in a highly adapted and continuously adapting system of responses. It therefore seems especially desirable that the psychobiologist approach the study of behavior open-mindedly and with entire willingness to describe the facts in accordance with their appearance and not in terms dictated by a set of assumptions which, however plausible, may ultimately turn out to be untenable. We avoid also in many connections the use of the term habit because such activity as that of locomotion, eating, drinking is neither native nor acquired, but a combination of the two, and it is perhaps the most important task of the investigator to discover the elements of this combination, their mode of association, and their ultimate functional relations and values.

CLEANLINESS

Of the many forms, phases, or aspects of orang-outan behavior, many are omitted from this general chapter on natural history because they do not appear in the literature or are mentioned in such fashion that no fact is definitely established. This peculiar deficiency in knowledge is due chiefly to the unfortunate circumstance that no one has found it possible to follow closely hour by hour and day after day the life activities of the free wild orang-outan. Indeed, this has not been done satisfactorily even with captives. Yet there is at least one type of behavior formerly characterized as essentially instinctive, not previously considered and not logically belonging in the later chapters, on which there are enough reasonably trustworthy observations to justify report. We refer to the orang-outan's personal cleanliness, or care of its body, in nature and in captivity. Mention of the subject is rare, yet in the following citations we find the basis for certain tentative generalizations whose value may increase as they are compared with those for the other anthropoid apes.

Of his captive specimen Vosmaer (1778, p. 17) reports that she was careful and cleanly about the cage and would sometimes carefully wipe up urine from the floor with a rag. Referring to Captain Blanchard of the vessel which brought the specimen to America as his authority, Jeffries (1825, p. 572) writes:

> He kept his house on ship board, clean, and at all times in good order; he cleared it out daily of remnants of food, &c., and frequently washed it, being provided with water and a cloth for the purpose. He was very cleanly in his person and habits, washing his hands and face regularly, and in the same manner as a man.

Of one of their specimens, Schlegel and Müller remark:

> He was generally very neat, scratching himself in human way with the moderately long nails of his hands, which besides the scratching at times occupied his attention, and whenever anything dirty stuck to him, with obvious nicety, he rubbed it off on to the bars of the cage. In all his manners and actions he showed indisputably a very high degree of intelligence. (1839-44, p. 21.)

It is reasonable to infer from our fragmentary information about the orang-outan, and from what is known of the other primates, that during infancy and early childhood the animals are cared for by the mother and that this care extends to cleanliness. When the individual reaches an age of independence and self-dependence it presumably has acquired or acquires the behavioral activities related to cleanliness which are characteristic of the species. Avoidance of excrement is well attested in case of captive animals and it is perhaps not unreasonable to infer, although observational data are lacking, that the nest is

abandoned after one or at most a few nights' use because of its soiled condition.

Hermes (1876) and other authors also refer to the neatness, personal care, and cleanliness of the orang-outan, but without adding to the information which we have presented.

The significance of captivity and of tuition in connection with cleanliness can scarcely be overemphasized. Cramped quarters, especially when occupied by more than one individual, encourage untidy habits. The animals become careless in their person because of unfavorable environmental conditions. This is paralleled in the history of human behavior, where a bad environment discourages the development of good personal and social habits or tends to break them down, even if well established.

CHAPTER ELEVEN

CAPTURE, LIFE IN CAPTIVITY, AND DISEASES OF ORANG-OUTAN

UNDOUBTEDLY many methods of destroying or capturing the orang-outan have at various times been employed by man. Of the early contributions to this topic that of Aldrovandi is both quaint and illuminating. The methods enumerated by him are applicable in varying degrees to different sorts of primate and one may doubt whether many of them have been used successfully with the orang-outan. As a historical introduction to this section we quote at length from this author.

Since in marked swiftness of body and sagacity of mind the monkeys excel, therefore for their capture, as Diodorus Siculus reports, innumerable methods have been worked out by the hunters. The first: going into the woods of the monkeys, they pour water into a vase and wash their eyes and then the vase having been filled with a sticky substance they leave it there and go away. The monkeys imitating the hunters do the same thing with the sticky substance, and their eyes being closed with this sticky substance they are easily captured. The second, according to the same author: they put on shoes, carry others with them which they leave and then hide away. Then the monkeys come down from the trees and put on the shoes, but as the lacings have been drawn into many knots they are so impeded that when the hunters return they cannot run away and no attempt is made. [See our figure 2, p. 5.]

Others have been of the opinion that the shoes left in the woods to deceive the monkeys were made of lead and supplied with long ropes so that when they were put on and the lacings tied the monkeys could not move from that place, whereupon the hunter, running up, captured them. Strabo mentioned a different kind of shoes, which they were accustomed to put on after the fashion of a breech-cloth. These the hunters leave in the woods, with a sticky substance inside like the others. The monkeys put them on and being all sticky are easily taken into custody. Others, according to Gesner, use mirrors with long ropes, bind them to their heads before the monkeys. Then when the hunters are out of sight, the monkeys stand before the mirror and the hunters return and draw the monkeys by long ropes after them. The females which have young are caught by a different method: ordinarily they carry one youngster in their arms and the other one clings to their backs; if they are pursued by the hunter so that they run the danger of capture, they put down the young one carried in their arms, but are hindered by the other one and running being impeded, since they cannot escape they are taken captive with their young. Moreover, according to Atheneus, these animals delight in wines. They can easily be intoxicated, which Aelian in various stories seems to confirm. If the elephant and the monkey are overcome with wine, the latter forgets its cunning and the other its strength. Wherefore in this manner, loving much wine, they are made not only weak but also are rendered unable to resist the wiles of the hunters. Finally, by means of arrows or firearms they are seized when wounded or when falling from the trees. This we gather from Peter Matyrus, who says oftentimes hunters and others coming into the woods of the Indian shores have seen many monkeys leaping from tree to tree with a horrid clamor, and sometimes descending from the trees. Occasionally they have allowed the troops and other passers-by to stroke them, but when they perceive that a bow is raised and arrows directed against themselves, quicker than the wind, they carry their clamor back to the highest trees. They shout vehemently. Then they are possessed of so great dexterity that they avoid arrows and are even said to catch them in their hands, but when they have not yet learned to avoid the shots of the weapons, many are killed in that fashion. But when they saw one of their number wounded or killed and falling precipitately from the tree they made so great a racket that they sounded like the roars of a thousand lions. But we cannot keep from admiring one, which we learn from Peter Matyrus, was very much wiser than the others in many ways, was able to seize the stones in one hand and with his mouth, and carry them with him into the trees and thence throw them down upon those passing below, while the hunters tried their best to throw the stones up at him. (Aldrovandi, 1637, pp. 230-231.)

Although ordinarily even the mature orang-outan is not aggressive, it may on occasion determinedly defend itself. A notable instance is that reported by Wurmb (1781, p. 144),[1] on the authority of Palm,

[1] See quotation by Radermacher of same authority in this volume, p. 25.

who of the capture of an old male specimen reported that it defended itself furiously with sharp branches which it broke from the trees so that it was impossible to capture it alive. Although there is no ground for questioning the accuracy of Wurmb's report, it is well established by the records of other observers that the animals usually seek to avoid the hunter and that they defend themselves with hands and feet, or possibly in certain instances with objects such as branches which may be used as weapons, only when escape is cut off.

The naturalistic accounts of Schlegel and Müller record with detail the methods of hunting and capturing employed by the natives of Borneo a century ago. In hunting to kill, poisoned arrows discharged from blow guns were commonly employed (1839-44, p. 25), and when it was desired to take specimens alive and uninjured it was the custom to destroy the mother with poisoned arrows and catch either the baby which she was carrying or a somewhat older and less dependent child which accompanied her. The early morning hours were considered by the native hunters most favorable for location and either destruction or capture of the orang-outan. As the animals arise only after the sun is high they may be discovered in their nests in the early morning and surrounded and wounded before they have opportunity to escape to the treetops for concealment. The need of extreme caution in approaching the animals is emphasized, since according to Schlegel and Müller they are keenly sensitive to sounds. These authors agree with their predecessors in stating that even the adult depends for escape from the hunter on caution, cunning, and means of concealment instead of on aggressive defense (1839-44, p. 28).

By the middle of the nineteenth century when Wallace made his naturalistic study of orang-outan life, the rifle had become the convenient and effective instrument of destruction and marksmanship was a prime requisite for the killing of orang-outans. As Wallace found it necessary to kill many specimens, much of his text consists of descriptions of shooting and the behavior of the animals in the course of destruction. The Dyaks, he says, agree that the animal does not use its powerful teeth either offensively or defensively and never attacks other animals unless at bay (Wallace, 1856a, p. 29).

Strikingly similar to the narratives of Wallace are those of Hornaday, who as hunter obtained during a single collecting trip in Borneo forty-three specimens of orang-outan. Of greater psychobiological interest than his descriptions of marksmanship and the death agonies of the animals are his observations on the behavior of the occasional specimen which was taken alive. Of one such, an infant, secured after destruction of the mother, he writes:

> We sprang to secure the baby, but it was under water fully a minute before we found it, quite unable to swim and very nearly drowned. We managed to resuscitate it, however, then the other two were lifted into the boat and we drew out into the stream.
>
> As soon as the baby recovered the use of all its faculties, it seemed possessed of a little devil. It was only about six months old or eight at the most, and weighed about eleven pounds, but it had the temper of a tiger. It made such persistent efforts to pull my hands up to its mouth in order to bite them that I was obliged to tie its elbows together behind its back, pinion its feet also and make it fast by a cord to the side of the boat, so that it could not reach me with its teeth. This, of course, increased its rage.
>
> It was restless as an eel, and gave me endless trouble. Once when I was not watching, it rolled over and before I was aware of the movement seized the calf of my leg between its teeth with a perfectly fiendish expression and bit me very severely. But for my thick woollen stockings and cotton hunting trousers underneath, I think the little wretch would have bitten out a piece of my flesh. I gave him a sounding slap on the side of his head, which caused him to let me go; but for many days after I carried a large black and blue mark in memory of him. (Hornaday, 1885, p. 368.)

A more nearly up-to-date description and discussion of methods of capturing the orang-outan is supplied by Lenz, who states on the authority of others that in

Fig. 51. Infant female orang-outan, said to be about six months old. Photograph by Newton Hartman, courtesy of Philadelphia Zoölogical Garden.

order to capture it alive the natives drive it into a somewhat isolated tree from which it may not escape directly to surrounding trees. They then clear a circle about the tree and surround it either by a circle of fire or a line of men. The animal, it is said, will not go through the fire. It is confined to the tree until it becomes so hungry or thirsty that it descends for food and drink. In the meantime the natives place

at the base of the tree small fruits and a vessel containing a sweetened mixture in which the effective constituent is the juice of the tuba, a climbing plant. This sub-

Fig. 52. Youthful female orang-outan, about four years old. Courtesy New York Zoölogical Society, E. R. Sanborn, photographer.

stance in small quantities induces unconsciousness and in larger amounts death. It is used by the Dyaks in catching fish, which it stupefies when mixed with the water. Red pepper or pepper water is used in some instances to blind the animals. This is especially effective in the capturing of young specimens after the parent or parents have been destroyed (Lenz, 1895, pp. 10-12).

A graphic description of an attempt to trap adult orang-outans is given by Mayer (1923). The facts appear in a popular article and are unverifiable by us.

In general, it appears that the orang-outan is peculiarly difficult to take alive because of its rarity, its extreme arborealness, and its tendency to avoid man by seeking the depths of the forest and when pursued by concealing itself in the tree-tops.

Of the ability of this great ape to adapt to conditions of life in captivity, much may be gathered from the numerous accounts of captive specimens. There is general agreement that adaptation is inversely related to age, but even among immature individuals there are marked differences in rate and degree of adaptation. It has commonly been stated that climatic factors are of major importance in the life of the organism, that it is extremely sensitive to changes in temperature and humidity and unable to withstand their unfavorable influence. On this point many authorities might be cited; we mention only Schlegel and Müller (1839-44, p. 23). Opposed to the view that the orang-outan cannot readily and successfully adapt to variations in temperature or moisture or to widely differing climates is Mitchell, whose opinion based upon extensive experience with captive apes in London is summed up in the following paragraphs.

The climate from which a bird or mammal comes has the smallest possible relation to its viability in captivity. A. Heilprin (*Distribution of Animals,* Int. Sci. Series, vol. lviii., 1887, p. 35) pointed out the error of the common belief as to climate being the principal factor that regulates or controls the distribution of animals. Amongst mammals and birds a vast majority of species and genera regarded as tropical have an actual or recent range into temperate or even frigid climates. Of those now limited to the tropics, still fewer are accustomed to a steady temperature. Some range periodically or occasionally to altitudes where great cold occurs; others, by exposure to the intense radiation of the dry air of plains at night, regularly endure cold going down to freezing-point; whilst many inhabitants of tropical forests (which we naturally associate with steamy heat) must be subjected to great cold in their nocturnal wanderings on the summits of tall trees. The abundance of thick hair and fur and of close feathering amongst tropical creatures is a clear indication that their life is not spent basking in tropical sunlight. Mammals and birds have the power of maintaining their internal temperature at a normal that varies only within an extremely narrow range, notwithstanding the temperature changes in their environment; and I do not doubt, not only that they can endure considerable cold, but that even rapid and considerable changes of temperature are a necessary stimulus to their viability.

On the other hand, there are cases where the change to the climate of London is certainly trying, but these occur not amongst tropical but temperate or arctic animals. The production of a thick coat against the onset of winter cold, and its doffing when summer approaches, appear not to be direct reactions to temperature but organic rhythms adapted to the seasons in the natural habitat of the animals. Thus animals from the far

North, accustomed to the short arctic summer, retain their thick coats in this climate long after their possession is cumbersome. Still worse is the case of animals brought from South temperate

Fig. 53. Mature male orang-outan, Max, drawn from life while captive in Paris. From Delisle, 1895, plate II, by permission du Muséum d'Histoire Naturelle.

zones, which begin to moult their thick coats when our winter, their summer, approaches. I have not information as to how soon if ever these rhythms readjust themselves to the reversed conditions. It is clear, on the other hand, that part at least of the mechanism by which coats become warmer, is direct stimulation from the surrounding temperature, and such different creatures as Carnivora and Baboons rapidly get better coats when exposed to the open air. The seasonal rhythms connected with breeding are also a cause of mortality to young or adults, when the conditions of climate are reversed. Birds from the Southern hemisphere, if they survive, appear to readjust themselves in this respect; it is more doubtful if mammals do so.

The idea that it is a fundamental necessity to protect healthy adult mammals and birds from cold by providing them with artificial heat is fallacious. The supreme necessity is free access to open air. In most cases this should be combined with shelter from rain and wind, and in some cases the shelter should be supplied with artificial heat—perhaps often even in excess of what is now customary—but only so far as it can be arranged without any detriment to fresh air. I think this is probably specially important in the case of nocturnal animals; as we are accustomed to see these asleep all day in the warmest corner given them, we are disposed to forget that at night they move about actively often in great cold.

For all mammals and birds steady exposure to an even temperature is unnatural and unhealthy; change is a necessary stimulus, and permanent existence indoors is the worst possible condition for viability and longevity. (P. Chalmers Mitchell, 1911, pp. 543-544.)

We have quoted the opinion of Mitchell with approval, and we would further state that our own experience with captive orang-outans, as well as other manlike apes, is entirely confirmatory of his observations and in our judgment justifies his general conclusion that a high degree of adaptableness to climatic factors is possessed by the primates. Requisite instead of the particular climate of birth or constancy of temperature and humidity is the possibility of self-protection through shelters, bedding material, clothing, or coverings.

The experience of those who have suc-

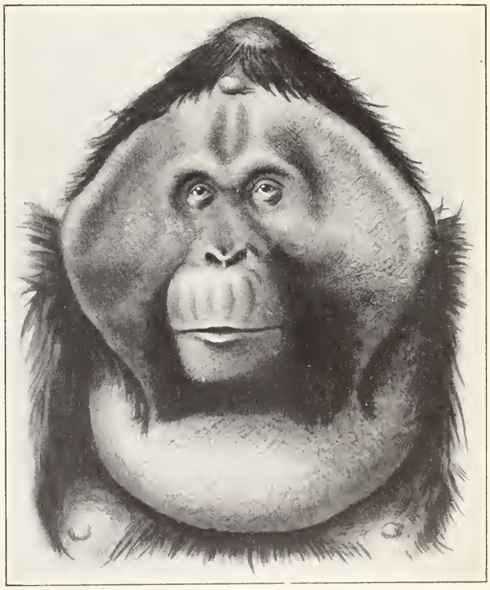


Fig. 54. Old male orang-outan, Maurice, with immense cheek pads and fold of skin at throat. Drawn from life while captive in Paris. From Delisle, 1895, plate I, by permission du Muséum d'Histoire Naturelle.

cessfully kept orang-outans in captivity indicates need of sufficient space and freedom for exercise and play. This is espe-

cially important for young specimens. The adults and the aged are relatively inactive, lacking, it would seem, spare energy. Given a reasonable amount of freedom of action, preferably with trees or other objects which can be climbed, sunshine, fresh air, and suitable shelters from wind, rain, sun, and fluctuations of temperature or moisture, even the mature orang-outan may, and often does, adapt fairly well to captivity.

Of the dietary requirements of the orang-outan nothing is definitely known. A balanced ration has not been developed and captive specimens are fed according rather to the convenience, whims, or prejudices of their keepers or their own expressed desires than in the light of scientifically determined nutritional information. No curves of growth are available for the orang-outan, and in the absence of information concerning the normal rate of growth and the characteristics of balanced ration, doubtless the safe course in maintaining captives is to follow the human dietetic rules, accustoming the animals to a varied diet and regulating quantity as well as variety in accordance with physiological condition of the organism and its appetite. What little is known about the general physiology of the orang-outan is indicated by brief statements or references in Sonntag (1924a).

There are also certain social conditions and requirements for adaptation, and although they seem to be far less important for the orang-outan than for the chimpanzee, there are reasons for supposing that they deserve attention. In other words, to keep the orang-outan in complete isolation from others of its kind and other organisms, and without even occasional human companionship for play and exercise, is likely to prove unfavorable to adaptation in captivity.

The domestication of the orang-outan has never, it seems, been completely achieved. They occur, to be sure, as pets, stage performers, and domestic servants, but in no one of these capacities are they wholly successful. As pets they rank next to the chimpanzee in the opinion of most observers, although there are those who prefer them to the chimpanzee. They are more readily adaptable to captive conditions, more friendly, playful, and entertaining than the gibbon and gorilla, but distinctly less so than the chimpanzee. Except in the early stages of life, their awkwardness and unsightliness count against them. We shall not in this connection cite authorities, for almost every description of a captive orang-outan refers more or less explicitly to such facts as in our opinion justify the above varieties of general statement.

As stage performer the orang-outan is rare by comparison with the chimpanzee. It is readily trained to manlike habits of eating, drinking, and occasionally to care for its quarters, but it is not so well adapted either structurally or temperamentally to acts of skill and to entertaining performances as the chimpanzee. Authorities differ as to capacity for training, some asserting that it is even more easily trained than the chimpanzee, but the majority maintain the opposite. Occasionally a performing orang-outan is discovered, but for every such there appear perhaps a dozen or a score of chimpanzees. Several orang-outans well known in their time in Europe are mentioned by Knauer (1915).

As laborer or domestic servant the orang-outan is relatively successful. Apparently it takes more kindly to work or drudgery than does the chimpanzee, but seldom has it been so thoroughly domesticated and broken to manlike habits that it willingly and with good nature performs monotonous acts. The scanty records seem to indicate that it is considerably superior to the chimpanzee and that occasionally an individual is really useful to its owner. The reliability of the reports we are inclined to question, and their scantiness justifies the general statement that the potential value of this great ape as a servant of man is economically negligible. Among those who have contributed first- or secondhand observations on this subject are Schouten (1707), Rennie (1838), Garner (1892).

To sum up our discussion of domestication, even at its best the orang-outan is only partially domesticated. Tamed it may be, as pet, performer of tricks, or manual laborer, but neither its physique nor its temperament qualifies it highly for any one of these specialized relations to man.

All authorities who have basis for opinion agree that the orang-outan has remarkable strength and vitality. In support of the general assertion we call upon Vosmaer (1778), Schlegel and Müller (1839-44), Deniker (1882), Wallace (1869), and Bauman (1923). Especially in the stories of hunters appear frequent accounts of the amazing strength of the animals when hunted, and notably when wounded, in breaking off and using branches, and no less frequent are the accounts of difficulty in killing adults.

Of the diseases and disabilities to which the orang-outan is subject in nature almost nothing is known (Keith, 1896, 1914). Sonntag (1924a) is our most recent authority for this generalization. Inferences have been drawn from the condition of captured animals as to the liability of the species to diseases and senile changes which are characteristic of man, but so uncertain are these inferences that they barely deserve mention. Senility certainly manifests itself in marked changes throughout the skeleton, and most of the estimates of age are based on condition of teeth, skull, and other skeletal remains of specimens. The natives, according to Hornaday's report (1885, p. 362), believe that the orang-outans in Borneo are subject to certain fevers and when afflicted seek the river banks. Numerous evidences of broken bones and flesh wounds on face and limbs from fighting are noted in specimens which have been killed or taken alive. Evidently the males are prone to fight, and Hornaday believes that occasionally they are peculiarly and aggressively pugnacious (1885, p. 402). Sonntag (1924a, p. 438) refers to Duckworth (1912) as describer of numerous skeletal fractures resulting presumably from falls. It appears from all the evidence that the animals are able to survive very grave injuries.

Of natural enemies they have almost none, and it is highly doubtful whether adults are attacked by any animal of prey. For such scant information as we have discovered we refer to Schlegel and Müller (1839-44, pp. 26-27) and to Wallace (1856a, pp. 28-29), from whose accounts, based primarily on native reports, it would seem that the crocodile is a formidable foe of the orang-outan and that some of the large members of the cat tribe may occasionally destroy immature specimens, although it is not indicated that they commonly attack adults.

Although undoubtedly hundreds of orang-outans have died in captivity, and even within reach of scientific observers, the cause of death has seldom been definitely determined save in certain zoölogical gardens where records of autopsy are systematically kept. From such data as have accumulated it appears that internal parasites, respiratory disorders, disorders of the digestive system, diseases of the bones, and certain other types of affliction which appear also in man, are common causes of death. The subject is one which, although of extreme importance to those who would keep and use the animals, is so inadequately considered in the literature that we are unable to cite authorities. The following are some of the references from which we have drawn information: Schmidt (1878, p. 193), Reuvens (1889, p. 185), Sonntag (1924a, p. 447), Yerkes (1925, pp. 234 ff.).

CHAPTER TWELVE

SOCIAL RELATIONS AND LIFE HISTORY OF ORANG-OUTAN

SOCIAL RELATIONS

THE orang-outan appears to be distinctly individualistic as contrasted with the collectivistic gibbon. It is the least gregarious of the manlike apes and in maturity especially it tends to seek isolation. The family group is the social unit, but of its nature and constitution almost nothing is definitely known. Except during the mating season the adult males live alone, and it is said that the females go off by themselves to bear their young. Schlegel and Müller (1839-44, p. 13) report that the old females often are found two or three together, sometimes accompanied by young. At times, in addition to a clinging infant, there is an accompaniment of one or more semidependent youngsters.

Little is known about social life and relations, and such statements as we have made are based upon mere fragments of information. Schlegel and Müller, Wallace, and Hornaday, our chief original sources of observational data, agree that the animal exhibits marked preference for life either in isolation or in very small social groups, and further that the individuals are not sociable. It would then appear that the gibbon and orang-outan represent extremes in social tendency and that the chimpanzee and gorilla are intermediate.

In a general discussion of sociological differences between savages and anthropoids, Descamps (1920) affirms that the anthropoid family is less stable than that of the savage; further, that it is composed of a male, a female, and young, who leave the parents at about three years of age. Of the orang-outan he states that the young leaving their parents at this early age form separate groups. There is an increasing tendency toward solitariness as age advances, and the old males spend most of their time alone, whereas the females live with their young. The main reason, remarks this author, for isolation or small social groups in the orang-outan is the scarcity of food. Each individual in order to live must reserve to itself a certain territory. In Africa, where food is more abundant, this tendency is not so apparent among the anthropoid apes.

While accepting what Descamps offers as facts, one may question his explanation of the individualism of the orang-outan. It is pertinent to remark that in the same geographical area are found the most gregarious and the least gregarious of the anthropoid apes, namely, the gibbon and the orang-outan. Probably structure and psychobiological constitution are quite as important conditions of social relations and mode of life as are the nature and distribution of the food supply.

Intimately related to the facts considered by Descamps are the migrations of the orang-outan. It is doubtful whether these may be considered social phenomena, but certainly they are correlated with food supply and the seasonal growth and ripening of foods. It is pointed out by Schlegel and Müller that since the orang-outan, a large animal, subsists chiefly on vegetable products it is naturally compelled, in order to obtain the foods which it prefers, to move from region to region. Migrations, it is noted, occur more or less regularly; thus the animal at a certain season appears in the southern interior of Borneo. "He announces himself usually by a grumbling sound which may be heard from time to time during the night. His stay in a given place lasts no longer than the supply of food." (Schlegel and Müller, 1839-44, p. 20.)

Fig. 55. Orang-outan mother, Maggie, and infant son seven weeks old. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

During the fruit season, which is from the middle of January to the first of May, the food of the orang is the durian, mangosteen and rambutan which are usually found upon the hills. There are also other fruits which ripen at different times, such as the ráso and kapayáng, but of the former the orangs eat the shoots only. Besides these they devour the shoots of the Pandanus, and also the leaves of certain trees. During the hot months of May, June and July, they retire far into the depths of the forest and are exceedingly difficult to find, but during the season of the heaviest rains, *i.e.,* from August to November, when the forests are quite flooded, the orangs are found in the vicinity of the rivers. (Hornaday, 1879, pp. 444-445.)

The statements of Schlegel and Müller and Hornaday are supported also by those of Shelford (1916, p. 3), who observes that the animal is a great traveler, seldom remains in a district for any considerable length of time, and suggests as explanation the fact that its dependence upon fruits compels migration.

Authorities agree that, in their relations with one another and with other types of animal, orang-outans are not ordinarily aggressive or quarrelsome. The males, it is well attested, may fight with one another, but even they seek to avoid hunters and defend themselves only when at bay. Again we call upon Schlegel and Müller, Wallace, and Hornaday, for supporting observations.

Varied evidence of interest of orang-outans in other animals appears in descriptions of behavior of captive specimens. The social behavior varies extremely in these several accounts, but in reading them it is, of course, needful to consider the facts of age, sex, experience, and temperament. Commonly the creatures are friendly with man and their confidence is easily won by kindly and fair treatment. Varied scientific value appears in descriptions of the social relations of orang-outans with other animals as reported by Grant (1828), Warwick (1832), Schlegel and Müller (1839-44), Schmidt (1878), Hornaday (1879, 1885), Priemel (1908), Sokolowsky (1908), and Heck (1922). But in no instance is reasonably complete and systematic account of social relations in the species or family group offered. Apparently this information is not available. Presumably it has proved extremely difficult to obtain in nature, and probably it has never happened that individuals constituting a harmonious social group became available in captivity for observation by a student of behavior.

The patchwork of facts which the literature supplies seems to indicate a very high degree of self-sufficiency in amusement or in daily tasks on the part of even the young or immature orang-outan. He is not ordinarily lacking in interest or curiosity, but as contrasted with the chimpanzee he is far more self-contained and individually resourceful. Somewhat illuminating in this connection are the descriptions of response to mirror images as given by Grant and Schmidt. Of these authors the former contributes meagerly.

Monkeys in general evince much surprise on seeing themselves in a looking-glass. Our *Homo sylvestris* [orang-outan], however, exhibits no emotion whatever at the reflection of his own rueful countenance. This is rather remarkable, considering the curiosity that he exhibits on any other point. (Grant, 1828, p. 12.)

Schmidt provides a more detailed and valuable description of the behavior of a young male orang-outan when confronted with a large mirror.

Noticing the strange object he quietly approached it and observing the reflection of the cage paused as if in response to the sudden change in his visual surroundings. Presently his curiosity drew him to the mirror, but he approached without the haste, restlessness, and other emotional expressions commonly exhibited by baboons and other monkeys. Seeing his image in the glass he paused suddenly, his hair bristled, his lower lip was protruded and he hurriedly retreated to the furthest end of the cage. Shortly regaining his confidence he again approached the mirror as if to investigate the strange phenomenon, but once again his courage failed and he fled from the image. Somewhat later, convinced it seemed that there was no danger, he sat before the glass and looked intently at the

image. Then he grew bolder and, as the author puts it, dared to defy his enemy, not as do monkeys with cries and vigorous movements but by spitting at him. As this means of aggression failed to provoke response, he took up a wooden hammer and flung it at the image. Crusts of bread were thrown also so that they struck the head of the mirror image. When the glass was moved slowly toward him he became excited and hastily fled to the rear of his cage. But again reassured by lack of aggressiveness on the part of the image, he became friendly in his actions and producing a ball displayed it, rolling it about, and apparently invited the other animal to play with it. Also he brought a piece of paper and holding it toward the image waved it to and fro as he was wont to do in attracting the attention of a child.

Schmidt expresses the opinion that the orang-outan did not recognize himself, since he made no movements or grimaces. People as imaged in the mirror he apparently recognized, for at times he would gaze at their images and then look around at them as if to assure himself they were actually present. The mirror finally was removed lest this captive ape should become too much attached to his new companion, and it is said that the disappearance of the image amazed the orang-outan not less than its appearance. For a time he continued to gaze at the place on the wall where the new world had appeared to him and he approached it from all directions in turn as if to assure himself that nothing remained. (Schmidt, 1878, pp. 230-232.)

Response to the mirror image is significant alike in studies of social relations, self-consciousness, and aspects of intelligent adaptation. We have not discovered more sustained and detailed observation of the behavior of the orang-outan in presence of mirror images than that of Schmidt. Evidently there is need of further development and utilization of the method in displaying or demonstrating, if not also in analyzing, the social behavior of the ape.

Statements concerning the playfulness of the orang-outan are somewhat contradictory, due possibly to the extreme variations in behavior with age. It is definitely known that the young animals are somewhat playful among themselves and eagerly seek amusement by contact with other animals. In common with the other anthropoid apes they show marked preference for children as contrasted with human adults.

A few fragments of description will illustrate our general statements.

Of the young orang-outan observed by him on shipboard Abel notes that it made friends of some human associates but paid little attention to some small monkeys which, however, persistently sought its company. Favorite forms of amusement were hanging by his arms from ropes and romping with the ship boys.

> He would entice them into play by striking them with his hand as they passed, and bounding from them, but allowing them to overtake him and engage in a mock scuffle, in which he used his hands, feet, and mouth. If any conjecture could be formed from these frolicks of his mode of attacking an adversary, it would appear to be his first object to throw him down, then to secure him with his hands and feet, and then wound him with his teeth. (Abel, 1818, pp. 327-328.)

Of the social relations of a female orang-outan and a male chimpanzee in captivity Warwick (1832, pp. 306-307) says that there was no indication of mutual attachment or tenderness and that the companionable and sociable habits of the chimpanzee far exceeded those of the orang-outan. Use of objects as playthings has repeatedly been observed and reported. Of the young male whose response to a mirror image has already been described, Schmidt (1878, p. 225) notes that it used tree trunk, rope, ladder, bars of cage, wooden ball, and wooden hammer as means of amusement. Thus Hornaday describes the playful behavior of one of his young orang-outan captives:

> The Old Man soon grew fat and mischievous, and always did his best to amuse me. Many an absurd childish game we played upon the floor in highly undignified fashion. One of his favorite

tricks was to seize my hand suddenly, draw it to his mouth, and make a feint of giving it a terrible bite. But he always knew that he must bite gently, which is more than can be said of any human infant I ever experimented with. Often he would entertain me for half an hour by making the most comically wry faces, for which his broad, india-rubber lips were specially adapted. He was also a great contortionist, and, having no *ligamentum teres,* the freedom with which he used his legs was at first quite surprising. (Hornaday, 1885, p. 383.)

According to Miller (1896) "never do the hunters, or the natives of Borneo, where this baby [orang-outan] lives, see troops of youngsters at play together in the woods, as they do of other young monkeys, but each young orang stays quietly with his mother till he is able to care for himself." Because this authority is dependent upon the observations of others and has adduced no new evidence, we are inclined to question the reliability of her generalization and to infer from the entirely unsatisfactory information at our command that if young orang-outans do not play together on the ground as do chimpanzees and gorillas, they probably use the trees and vines of the jungle as their natural playground. Not only do captive young orang-outans play together freely, although by no means so boisterously as do some of the other anthropoid apes, but occasionally they have been observed to invent simple modes of amusement in the nature of games or novel motor expressions.

The following from Priemel (1908, p. 82) is an admirable illustration. This author tells of the clownlike behavior of a captive female orang-outan whose favorite toy among wooden hoops, balls, and rings was a wooden rocking-horse. This ape invented a dance which the observer presents as an excellent example of the modern art. Standing with body weight on the left foot and on the right in turn, the animal thrust its right hand straight forward, then flung it to its side, simultaneously striking its breast with the left hand and then reversing the movement with the arms and hands. As a variation, the body was turned through 360 degrees on one foot.

The sum of our present knowledge of the social relations of the orang-outan justifies the tentative conclusion that it is relatively quiet, placid, slothful, and self-sufficient. For it social stimuli and social environment have far different and almost certainly relatively little value by comparison with the chimpanzee. Köhler (1921a, p. 73), in emphasizing the essentially social nature of the life of the chimpanzee, has quite appropriately questioned the naturalness of the adaptive behavior of this ape in isolation, and extending his generalization he has suggested that experimental studies of the behavior of the isolated orang-outan may yield misleading results. The content of orang-outan literature would suggest on the contrary its relative independence of the factors of social environment and its ability to live contentedly and adapt itself with the usual measure of success in nature or in captivity as an isolated individual. We have put the case strongly merely to bring into clear light the remarkable contrast in social relations between the orang-outan of the Indies and the chimpanzee of Africa.

LIFE HISTORY

To follow the psychobiological history of the orang-outan from conception, through development and senile decline, to death is impossible because of the extreme paucity of information. The reproductive behavior of the wild ape is practically unknown. Doubtless phases of it have been observed, but for one reason or another scientific records have not been made. There are some references to sex behavior, but only in one case, that of Fox (1929), is scientific value conspicuous. Vosmaer (1778, p. 17) mentions the examination of a kitten by a female orang-outan whose behavior suggested sexual interest; and Pocock (1906, p. 562, footnote) states that masturbation is by no means uncommon in the males of certain anthropoid apes, including the orang-outan, but rarely occurs in the females. Under the promising title, *The Sexual Life of the Anthropoid Apes,* Sokolowsky (1923), after

commenting on morphological characters of sex, indicates lack of available information concerning sex behavior in the orang-outan. Sonntag (1924, p. 269) states without qualification, and apparently with intended application to the three great apes, that copulation occurs in the position characteristic of quadrupeds. Whereas Fox (1929) describes the copulatory position in orang-outan as face to face.

That there is a definite mating season, and consequently also seasonal production of young, is implied by the reference of naturalistic observers to the social relations of the sexes, but we have failed to find definite statements or evidences concerning the seasonal relations of reproductive activities or the time, place, or circumstances of parturition. Only one instance of the breeding of orang-outans in captivity has been discovered (Fox, 1929). Evidently our knowledge of the ontogenesis of sexual behavior, including such important assemblages of phenomena as sex play and mating, is in its beginnings. One marvels at this because although certain of the phenomena may be difficult to observe, this cannot be true of all, and it would seem that competent naturalists, if interested in life history, should already have contributed much more largely to the fund of information.

The age of sexual maturity, although not definitely ascertained for either sex, is thought to approximate eight years in the female and ten in the male. Some of the evidences in support of this statement will be presented in the following discussion of the phenomenon of menstruation.

After noting that Buffon considered menstruation specifically human, Blumenbach (1775, pp. 90 and 182 of 1865 ed.) indicates his agreement, and although he does not refer to the orang-outan, it may safely be inferred that he meant to include it in his generalization.

Mention of the failure of what appears to have been an adult female to menstruate is made by Vosmaer (1778, p. 13), who states that particular attention was given to the question of menstruation, but with negative result.

Uninfluenced it would seem by desire to distinguish man sharply from the other primates, d'Obsonville (1783, p. 370) asserts that the orank-outank (used as inclusive of chimpanzee and orang-outan) exhibits periodic menstrual flow. He is cited on this point by Monboddo (1784, p. 361) and Grant (1828, p. 19).

In a female weighing sixty-six pounds, and estimated as seven years old, Priemel (1908, p. 84) failed to discover evidence of menstruation. Possibly this was due to the conditions of captivity, since it is now well known that improper nutrition and otherwise unfavorable or unhealthy conditions of captive existence may radically alter or interfere with physiological processes.

The subject is briefly referred to by Sonntag (1924, pp. 269-270), who in summarizing information indicates without explicit statement that the menstrual phenomenon appears in the orang-outan, but says "nothing is known of the duration, periodicity or quantity of the menstrual discharge in the Gorilla and Orang."

Considering the fragmentary and utterly unsatisfactory evidence, we may tentatively conclude that menstruation normally occurs, presumably with approximately the same periodicity as in man.

From observation of a group of orang-outans at the Abreu primate colony, Havana, Cuba, Yerkes (1925, p. 55) infers that a male specimen, estimated to be not less than ten years old, was adult, and that two females estimated at six to eight years old were not yet sexually mature.

On the period of prenatal life or gestation also there is a dearth of information. D'Obsonville (1783, p. 370) gives the term as seven months, but qualifies his statement by saying that the animals do not breed in captivity and that the duration of prenatal life probably is estimated from the observation of females captured during pregnancy.

In our own time, Keith, from careful

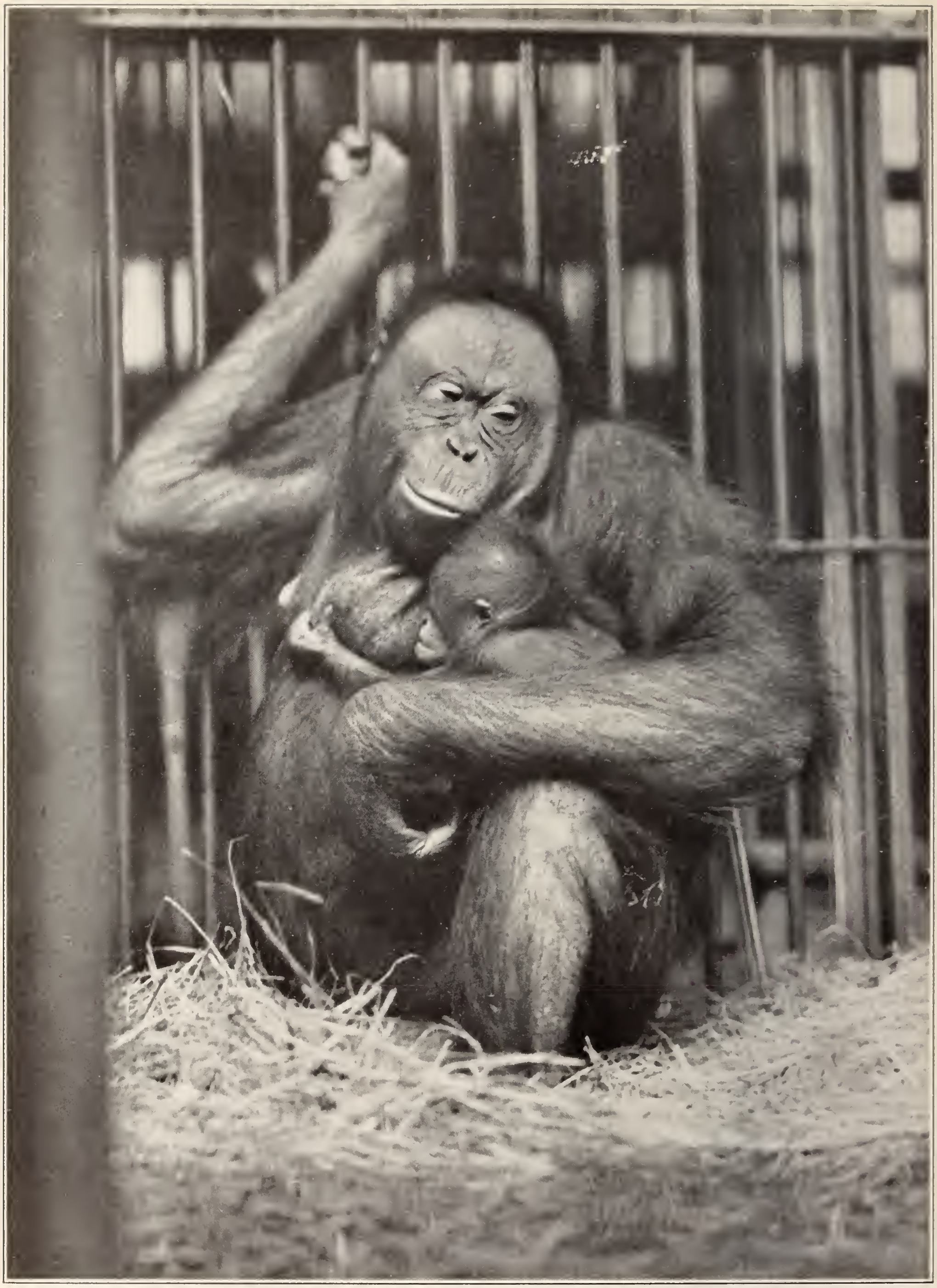


Fig. 56. Maggie and her month-old son in characteristic positions and relation. Photograph by Newton Hartman, courtsey Philadelphia Zoölogical Garden.

examination of the recorded evidences, offers the following as his opinion.

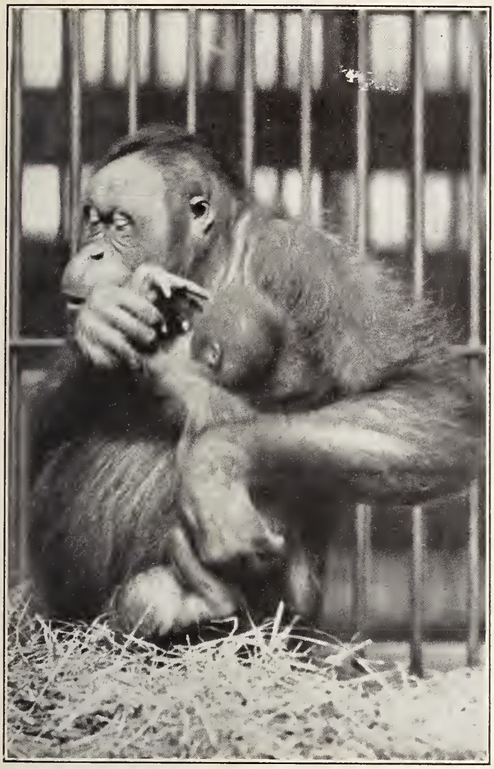


Fig. 57. Maggie and son. Maternal restraint. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

In ordinary monkeys the prenatal life-period is seven months; the period of growth—of infancy and adolescence—is about seven years, and the total span of life about 21 years. In anthropoids the prenatal period is apparently nine months, the same as in man; the period of growth about 12 years, and judging from the wear of the teeth and the changes which took place in the skull and skeleton with age, it was possible that the full term of life amongst great anthropoids might extend to 35 or 40 years. (1914, p. 224.)

It is clear enough that the duration of gestation in the orang-outan is not known. According to their particular bias or what they consider the indications of evidences, authorities choose either the period for the monkeys, six to seven months, or that for man, nine months. We have failed to discover satisfactory basis for either guess.

With reference to parturition, care of the young, and other aspects of parental behavior, the story of our ignorance repeats itself. Schlegel and Müller and their copyists without end, refer to the tendency of the female to seek isolation somewhat prior to childbirth, and both Wallace and Hornaday refer to single birth as typical.

These authorities believe also that the mother may continue to nurse her offspring into the third year. Probably, however, the infant is weaned during the second year. Whether the father assists in looking after the offspring is uncertain, but what little is known about the segregative tendencies of the sexes would suggest the inference that the female is alone responsible for parental duty.

The following announcement from the Philadelphia Zoölogical Garden is pertinent and of unusual interest:

Fig. 58. Maggie and son. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

On September 25th an Orang-utan was born in the Garden and is doing well. This is the first born in the United States and, with the exception

of one born in Berlin, Germany, and killed by its mother the second day, and possibly one other born in Singapore, of which there is no clear record, is the only one born in captivity. The little one, a male, weighs about five pounds. Its mother, "Maggie," was acquired in 1926, and the father, "Chief Utan," was presented to the Garden by Mr. B. Dawson Coleman, a Director of the Society, on September 13, 1927. (*Bull. Zoöl. Soc. Phila.*, August-September, 1928.)

Of the mated pair in Philadelphia the female is supposed to weigh about 130 pounds, the male about 175 pounds. The animals came from Sumatra. Their ages are unknown.

From October, 1927, until April, 1928, "Maggie" and "Chief" were caged together. Pregnancy was first suspected in January, 1928. The female suffered severe and persistent constipation from February to May. During this interval her appetite was poor and the bowels rarely moved. Late in May the bowels became normal and appetite promptly returned (Fox, 1929, p. 38).

From May, the condition of "Maggie" continued to be excellent. About the middle of August she became "peevish and quite irritable." The following is the published account of the birth:

When the keeper came on duty and made his first rounds on the morning of September 25, he found "Maggie" tenderly licking an apparently normal baby, still wet, and with cord and placenta still attached. Observations were limited as it was thought best not to risk disturbing her. During the day the little one was seen to move about in the mother's arms, at times reaching up toward her face. "Maggie" remained lying down the entire day, cuddling her baby close to her face, but making no attempt to get it near her breast. At times, she evinced a mild curiosity toward the placenta, picking at it and turning it over, but making no attempt to separate it from the infant. She took her usual amount of fruit, but would not touch water or any other liquid, although she was accustomed to taking one quart of milk a day. The following morning the baby was noticed as apparently searching for something with its mouth, at one time sucking on the mother's ear. The mother by this time, 6:50 A.M., on the 26th, was beginning to show more interest in the placenta and cord, picking up the cord with her lips, then removing it from her mouth again. At 10:00 A.M., estimated as twenty-eight hours after the birth, she took hold of the cord with her teeth, close to the baby's abdomen, severed it, and then pushed the placenta over against the bars of the cage. Immediately she took up the baby and held it against her breast. It promptly found the nipple and proceeded to nurse. A few minutes later, "Maggie" emerged for the first time from the shelter to which she had retired for her accouchement, and with the baby clinging to her breast, climbed to the roof of the shelter and began a thorough examination of her offspring. A rather curious incident, and one worthy of note, occurred at this time. The keeper, taking advantage of her absence from the den, gave it a thorough cleaning and put in a fresh supply of bedding. "Maggie" had been accustomed to sleeping in the west end of the enclosure, and it was there that the baby was born; but when she saw the clean bedding forthcoming, she immediately gathered it up, took it to the *east* end, made up her clean bed, to which she and the baby retired for a midday nap. Apparently "Maggie" appreciated the value of aseptic measures. (Fox, 1929, pp. 39-40.)

Subsequent reports indicate that both mother and baby are in excellent condition. At the date of writing the infant is approximately six weeks old. So far as we are informed, it has not been measured. We assume that the announced weight of five pounds is an estimate.

Only three other observations bearing on the size and weight of the infant orang-outan have been found. Wallace (1856, p. 390), describing a specimen which he considered the youngest ever observed by a European, estimated age approximately one month, gives the weight as three pounds nine ounces, the height as fourteen inches. The infant referred to above as born in Berlin, we are informed by Heck, Director of the Zoölogical Gardens of Berlin, was a first-birth which for only a short time survived the rough handling of the mother. After death it weighed 1,405 grams (about 3.1 pounds). By contrast, Hornaday (1885, p. 403) reports that a pregnant female, forty-four and three-quarter inches in height, captured by him, carried a fully developed fetus which weighed seven pounds three ounces. The disparity of weight in these specimens we are unable to explain.

The only accounts of the behavioral characteristics of infant orang-outans are

Fig. 59. "Chief Utan," father of the infant shown in figures 55-58. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

those of Wallace and Hornaday. Their scientific inadequacy and other shortcomings are obvious, but as our sole information they are worthy of reproduction.

The Wallace infantile specimen, captured when approximately a month old by the shooting of the mother, broke an arm and a leg when it fell to the ground, but so rapidly did they mend that the injuries were not suspected by Wallace until postmortem examination some months later revealed their scars. We quote Wallace's account of the infant.

[When captured the little one] had not a single tooth, but a few days afterwards it cut its two lower front teeth. Unfortunately, I had no milk to give it, as neither Malays, Chinese nor Dyaks ever use the article, and I in vain inquired for any female animal that could suckle my little infant. I was therefore obliged to give it rice-water from a bottle with a quill in the cork, which after a few trials it learned to suck very well. This was very meagre diet, and the little creature did not thrive well on it, although I added sugar and cocoa-nut milk occasionally, to make it more nourishing. When I put my finger in its mouth it sucked with great vigour, drawing in its cheeks with all its might in the vain effort to extract some milk, and only after persevering a long time would it give up in disgust, and set up a scream very like that of a baby in similar circumstances.

When handled or nursed, it was very quiet and contented, but when laid down by itself would invariably cry; and for the first few nights was very restless and noisy. I fitted up a little box

Fig. 60. Portrait of "Chief Utan" to show texture of skin, beard, and size of cheek pads. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

for a cradle, with a soft mat for it to lie upon, which was changed and washed every day; and I soon found it necessary to wash the little Mias as well. After I had done so a few times, it came to like the operation, and as soon as it was dirty would begin crying, and not leave off till I took it out and carried it to the spout, when it immediately became quiet, although it would wince a little at the first rush of the cold water and make ridiculously wry faces while the stream was running over its head. It enjoyed the wiping and rubbing dry amazingly, and when I brushed its hair seemed to be perfectly happy, lying quite still with its arms and legs stretched out while I thoroughly brushed the long hair of its back and arms. For the first few days it clung desperately with all four hands to whatever it could lay hold of, and I had to be careful to keep my beard out of its way, as its fingers clutched hold of hair more tenaciously than anything else, and it was impossible to free myself without assistance. When restless, it would struggle about with its hands up in the air trying to find something to take hold of, and, when it had got a bit of stick or rag in two or three of its hands, seemed quite happy. For want of something else, it would often seize its own feet, and after a time it would constantly cross its arms and grasp with each hand the long hair that grew just below the opposite shoulder. The great tenacity of its grasp soon diminished, and I was obliged to invent some means to give it exercise and strengthen its limbs. For this purpose I made a short ladder of three or four rounds, on which I put it to hang for a quarter of an hour at a time. At first it seemed much pleased, but it could not get all four hands in a comfortable position, and, after changing about several times, would leave hold of one hand after the other, and drop on to the floor. Sometimes when hanging only by two hands, it would loose one, and cross it to the opposite shoulder, grasping its own hair; and, as this seemed much more agreeable than the stick, it would then loose the other and tumble down, when it would cross both and lie on its back quite contentedly, never seeming to be hurt by its numerous tumbles. Finding it so fond of hair, I endeavoured to make an artificial mother, by wrapping up a piece of buffalo-skin into a bundle, and suspending it about a foot from the floor. At first this seemed to suit it admirably, as it could sprawl its legs about and always find some hair, which it grasped with the greatest tenacity. I was now in hopes that I had made the little orphan quite happy; and so it seemed for some time, till it began to remember its lost parent, and try to suck. It would pull itself up close to the skin, and try about everywhere for a likely place; but, as it only succeeded in getting mouthfuls of hair and wool, it would be greatly disgusted, and scream violently, and, after two or three attempts, let go altogether. One day it got some wool into its throat, and I thought it would have choked, but after much gasping it recovered, and I was obliged to take the imitation mother to pieces again, and give up this last attempt to exercise the little creature.

After the first week I found I could feed it better with a spoon, and give it a little more varied and more solid food. Well-soaked biscuit mixed with a little egg and sugar, and sometimes sweet potatoes, were readily eaten; and it was a never-failing amusement to observe the curious changes of countenance by which it would express its approval or dislike of what was given to it. The poor little thing would lick its lips, draw in its cheeks, and turn up its eyes with an expression of the most supreme satisfaction when it had a mouthful particularly to its taste. On the other hand, when its food was not sufficiently sweet or palatable, it would turn the mouthful about with its tongue for a moment as if trying to extract what flavour there was, and then push it all out between its lips. If the same food was continued, it would set up a scream and kick about violently, exactly like a baby in a passion.

After I had had the little Mias about three weeks, I fortunately obtained a young hare-lip

monkey (Macacus cynomolgus), which, though small, was very active, and could feed itself. I placed it in the same box with the Mias, and they immediately became excellent friends, neither exhibiting the least fear of the other. The little monkey would sit upon the other's stomach, or even on its face, without the least regard to its feelings. While I was feeding the Mias, the monkey would sit by, picking up all that was spilt, and occasionally putting out its hands to intercept the spoon; and as soon as I had finished would pick off what was left sticking to the Mias' lips, and then pull open its mouth and see if any still remained inside; afterwards lying down on the poor creature's stomach as on a comfortable cushion. The little helpless Mias would submit to all these insults with the most exemplary patience, only too glad to have something warm near it, which it could clasp affectionately in its arms. It sometimes, however, had its revenge; for when the monkey wanted to go away, the Mias would hold on as long as it could by the loose skin of its back or head, or by its tail, and it was only after many vigorous jumps that the monkey could make his escape.

It was curious to observe the different actions of these two animals, which could not have differed much in age. The Mias, like a very young baby, lying on its back quite helpless, rolling lazily from side to side, stretching out all four hands into the air, wishing to grasp something, but hardly able to guide its fingers to any definite object; and when dissatisfied, opening wide its almost toothless mouth, and expressing its wants by a most infantine scream. The little monkey, on the other hand, in constant motion; running and jumping about wherever it pleased, examining everything around it, seizing hold of the smallest objects with the greatest precision, balancing itself on the edge of the box or running up a post, and helping itself to anything eatable that came in its way. There could hardly be a greater contrast, and the baby Mias looked more baby-like by the comparison.

When I had had it about a month, it began to exhibit some signs of learning to run alone. When laid upon the floor it would push itself along by its legs, or roll itself over, and thus make an unwieldy progression. When lying in the box it would lift itself up to the edge into almost an erect position, and once or twice succeeded in tumbling out. When left dirty, or hungry, or otherwise neglected, it would scream violently till attended to, varied by a kind of coughing or pumping noise, very similar to that which is made by the adult animal. If no one was in the house, or its cries were not attended to, it would be quiet after a little while, but the moment it heard a footstep would begin again harder than ever.

After five weeks it cut its two upper front teeth, but in all this time it had not grown the least bit, remaining both in size and weight the same as when I first procured it. This was no doubt owing to the want of milk or other equally nourishing food. Rice-water, rice, and biscuits were but a poor substitute, and the expressed milk of the cocoa-nut which I sometimes gave it did not quite agree with its stomach. To this I imputed an attack of diarrhœa from which the poor little creature suffered greatly, but a small dose of castor-oil operated well, and cured it. A week or two afterwards it was again taken ill, and this time more seriously. The symptoms were exactly those of intermittent fever, accompanied by watery swellings on the feet and head. It lost all appetite for its food, and, after lingering for a week a most pitiable object, died, after being in my possession nearly three months. I much regretted the loss of my little pet, which I had at one time looked forward to bringing up to years of maturity, and taking home to England. For several months it had afforded me daily amusement by its curious ways and the inimitably ludicrous expression of its little countenance. Its weight was three pounds nine ounces, its height fourteen inches, and the spread of its arms twenty-three inches. (Wallace, 1869, I, 65-72; originally appeared, in slightly different form, in Wallace, 1856, pp. 386-390.)

Of the capture of a young orang-outan and its behavior toward him, Hornaday writes:

I espied a baby orang up in a tree-top, hanging to the small limbs with out-stretched arms and legs, looking like a big, red spider. It gazed down at us in stupid, childish wonder, and I was just aiming for it, when Mr. Eng Quee called my attention to the mother of the infant, who was concealed in the top of the same tree. As soon as I fired at her, she climbed with all haste up to her little one, which quickly clasped her round the body, holding on by grasping her hair, and, with the little one clinging to her, the mother started to climb rapidly away.

Fortunately, we were able to get the boat in amongst the trees without much trouble, and all immediately went overboard. We had scarcely done so when a third orang, a young male about two years old, was discovered looking down from a nest overhead, which he immediately left and started to follow the old mother. As he went swinging along underneath a limb, with his body well drawn up I gave him a shot which dropped him instantly, and then we turned our attention to the female. She was resting on a couple of branches, badly wounded, with her baby still clinging to her body in great fright. (Hornaday, 1885, pp. 367-368.)

Of another specimen, also thought to be

about six months old, but of very friendly disposition, Hornaday says:

> His eyes were large, bright and full of intelligence, and he had a forehead like a philosopher.
>
> Because of his bald and shiny head, his solemn, wrinkled and melancholy visage, his air of profound gravity and senatorial wisdom, we got to calling him the Old Man, and forgot to give him any Christian name. A thin growth of brick-red hair grew straight up the back of his head and over the crown, making, in certain lights, a perfect halo around his bald, brown pate, reminding one rather forcibly of certain pictures by the old masters.
>
> I measured him, for the first time, on October 15th, in spite of his vigorous opposition, and found that his height was 21¾ inches, extent of arms 34½ inches, and his weight 10½ pounds. His body was short and thick, and, like all orangs, his arms were so long and his legs so short that by stooping forward a little, his hands easily touched the ground. In walking, he invariably went on all fours, placing the back of the fingers and ball of the thumb, instead of the palm, upon the ground, and he also turned his toes under. His gait on the ground was very much like that of a man going on crutches with both feet injured alike. On the ground he moved slowly, seeming quite out of his element, but his feats in climbing and his performances on the slack-rope were highly entertaining.
>
> He was fresh from the jungle when brought to me, but I soon convinced him that my intentions were honorable, and slowly gained his confidence. For three or four days he would not allow me to hold him in my arms unless I would let him grasp some firm object with at least one hand. The action plainly showed that he feared I would play a trick on him by letting him fall. Presently, however, I hit upon a plan which conquered his suspicion. I made him climb up to my shoulder to get the bananas of which he was very fond, and, after that, a banana held at arm's length above my head would start him to climbing my body as if it were a tree until the tempting bait was reached.
>
> He soon became very fond of being held in my arms, and when I grew tired of holding him, he would grasp the folds of my flannel shirt and hold himself—quite an improvement upon the puny helplessness of human infants.
>
> Next to eating seven bananas at once, his greatest delight was in sitting lazily in my lap while I sat reading, writing, or even eating, sprawling out his legs and arms, catching hold of my book, or my penholder, or pulling at the table-cloth.
>
> Once while holding him in my lap at dinner, he suddenly made a pass at the roast duck which lay before me, and had his teeth in it before I could recover from my surprise. On one occasion when I sat eating, he leisurely climbed up the back of my chair, squatted on the topmost round, leaned lazily forward against me, and rested his chin comfortably on my shoulder. And there he sat all through the meal, watching the performance with the air of a connoisseur. (Hornaday, 1885, pp. 381-382.)

The orang-outan, if captured young, very speedily becomes tame and confiding, and the company of man a pleasure and a necessity, according to Schlegel and Müller (1839-44, p. 13). But these same authors indicate marked individual differences, since one specimen may be gentle and trustful, another wilful, stubborn, and treacherous. Referring to F. Cuvier's account of the young orang-outan, Schlegel and Müller (p. 22) state that their observations in the main agree with those of Cuvier. They especially emphasize the extreme difference in docility between specimens taken when very young and those taken as adolescents or adults.

There are, indeed, numerous useful descriptions of the behavioral traits of orang-outans ranging in age from two or three to five or six years, since this is the age range most frequently represented by imported captives. Many of these records are of extreme interest and of no little scientific value, but even the summarizing of observations would require an inordinate amount of space and it must suffice us to cite references. Nissle (1873), Schmidt (1878), Priemel (1908), P. C. Mitchell (1912), Shelford (1916), Yerkes (1916) are especially in point.

The adolescent period of orang-outan life is very imperfectly known, for the literature presents not a single systematic description. A number of specimens have been kept in zoölogical gardens or elsewhere through late childhood and early adolescence, but in most instances imported captives do not outlive childhood.

The behavioral traits of the mature orang-outan are reported in part by naturalistic observers and in part by those who have had opportunity to study adults in captivity. Schlegel and Müller dwell on the untamableness of the adult. It is in fact

only specimens which have been reared from early life in captivity which can be safely handled and studied to advantage in maturity.

Among the observers who have provided descriptions of adult or aged specimens particularly worthy of citation are Schlegel and Müller (1839-44), Boitard (1842), Friedel (1876), Delisle (1893), Bolau (1894), Lenz (1895a), and Fick (1895). Most of these authors give attention to exceptionally large and presumably also exceptionally old specimens which by some chance or other were for a time maintained in captivity. They agree in characterizing such specimens as little inclined to physical activity and seemingly self-centered and melancholy. Although occasionally a specimen is described as tractable, of good appetite, and easily maintained in health and contentment, usually the opposite is true.

Although the average span of life for this great ape is unknown, estimates and guesses of average and extremes are not lacking. Schlegel and Müller (1839-44, p. 14) say that the Dyaks attribute to the orang-outan a longevity of forty to fifty years, greater than their own; and these observers from their own data are inclined to agree with the natives, for in many specimens the teeth are much worn or only partially present and the sutures of the skull completely obliterated. There are also specimens with many fractured bones, indicating falls, and thus so crippled as to be unable to live the habitual arboreal life. On anthropological authority, Fick (1895) estimates the age of the old male Moritz in Paris as over fifty years, and Heck (1922, p. 647) offers estimates of the age of specimens ranging from fifty to sixty years. It is not improbable that the rate of development and the life span of the orang-outan, given like conditions, closely approximate those of man.

CHAPTER THIRTEEN

AFFECTIVE BEHAVIOR AND SPEECH IN ORANG-OUTAN

TEMPERAMENT

THE gibbon may be gentle, shy, timid, but certainly the orang-outan does not so impress the casual observer. Instead, the following are typical impressions and characterizations.

During his residence in Borneo, and the different excursions which he made, in every direction, through the primeval forests of that interesting island, Dr. Müller had frequent opportunities of observing the orang-outans in a state of nature, and of studying their manners in their native woods. He describes them as being in the highest degree unsociable, leading, for the most part, a perfectly solitary life, and never more than two or three being found in company. Their deportment is grave and melancholy, their disposition apathetic, their motions slow and heavy, and their habits so sluggish and lazy, that it is only the cravings of appetite, or the approach of imminent danger, that can rouse them from their habitual lethargy, or force them to active exertion. When under the influence of these powerful motives, however, they exhibit a determination of character, and display a degree of force and activity, which would scarcely be anticipated from their heavy, apathetic appearance; whilst their strength is so redoubtable, that, without the aid of fire-arms, it would be impossible to cope with them. (Rennie, 1838, p. 120.)

The faces of the more intelligent orangs are capable of a great variety of expression, and in some the exhibition of the various passions which are popularly supposed to belong to human beings alone is truly remarkable. I had in my possession in Borneo four young living orangs. Three were dull and untractable, but the fourth was a perpetual wonder to both Europeans and the natives themselves. I had that little animal in my possession for over four months, and for a number of weeks it lived in the room with me so that I watched it almost constantly. The expression of its face was highly intelligent, while the intellectual development of its forehead and entire cranium would have been quite alarming to any enemy of the theory of evolution. This specimen was a fine, healthy male infant from 7 to 8 months old, height 22¼ inches, extent of arms 37 inches, weight 15½ lbs. He exhibited fully as much intelligence as any child under two years of age, with all the emotions of affection, dislike, anger, fear, cunning, playfulness and even ennui. When teased beyond endurance he would first whine pitifully, but if continued he would throw himself upon the floor, kicking and screaming and catching his breath as loudly and naturally as any spoiled child. He was afraid of strangers as a rule, but decidedly attached to my Chinese servant and myself. When alarmed at the presence of a large dog or other animal he would shuffle up to me as fast as possible and climb with all haste into my arms. While the statement may seem frivolous in this connection, it is really a serious fact that, whenever a cat happened to come near him, he would immediately grab it by the tail with the very same action and bright mischievous expression of countenance as we have all seen in human children.

Fig. 61. Companionship as illustrated by young orang-outans. Courtesy F. W. Bond, photographer, and Zoölogical Society of London.

Male orangs are much given to fighting, as the numerous scars upon some of our specimens plainly show. Being purely fruit-eating animals their huge canine teeth seem to have been given them partly as weapons of defence and offence, and they use them to decided advantage. Like many roughs of the human species they seem given to attacking each other's fingers with their teeth, since their jaws do not open sufficiently wide to seize an arm or shoulder to good advantage. Some individuals are very pugnacious or else sorely persecuted. Orang No. 11, *Simia Wurmbii,* carried the scars of many a hard-fought battle in the treetops. A piece had been bitten out

of the middle of both upper and lower lip leaving a great ragged notch in each, and both his middle fingers had been bitten off at the second joint. Not only that, but on the feet, the third right toe had been bitten off, as well as the fourth left toe and the end of the hallux. This specimen we named "The Desperado." (Hornaday, 1879, pp. 442-443.)

With these varying descriptions in mind we may more particularly inquire concerning the temperamental or dispositional characteristics of this great ape. Reliable observations are by no means easy to obtain, for in nature scant opportunity is ordinarily offered the scientist for sustained and connected observation, and the data obtained from captive specimens are of uncertain value because of the untoward influence of inadequate nutrition, inactivity, and disease. There are indeed many brief and incomplete characterizations, but instead of quoting further at this point we shall bring together in orderly way, and according to a simple classification, the descriptive terms which most frequently appear and which presumably are most widely and exactly applicable in the various developmental stages and conditions of orang-outan life.

In respect to overt activity, the ape is commonly described as quiet, inactive, lethargic, sluggish, slothful, lazy, slow. Of measurements of time of reaction we have discovered none, but it is our impression from direct observation of many specimens of the anthropoid apes that in response to visual stimuli the orang-outan is slower than the gibbon and chimpanzee, although possibly somewhat quicker than the gorilla.

In bodily attitude the orang-outan commonly impresses the scientific observer as stolid, sad, depressed, and phlegmatic. When facial expression is considered in addition to bodily attitude, such terms are applied as grave, sedate, serious, thoughtful, reflecting, brooding, pensive, melancholy.

Finally, the total effect of the appearance of the orang-outan on the thoughtful and inquiring student of animal behavior is indicated by such expressions as lack of ambition, of aggressiveness, of determination, and of energy; discouragement, pessimism, decision that effort is not really worth while.

Helpful though these terms may be in enabling us to compare and contrast this creature with other anthropoid types, it is certain that no single, simple, or even complex formula for temperament is equally applicable to all individuals. It is definitely known that in both amount and character, activity varies extremely with age and stage of development, the young being relatively active, energetic, playful, and the old, sluggish and content to rest in quiet. In addition, scarcely less marked are the differences characteristic of individuality, sex, particular modes of experience, and pathological conditions. As one observes for himself, and seeks to supplement his first-hand information by searching the literature, he comes to suspect that adequate general description of the affective behavior of the orang-outan is a difficult and intricate task which up to the present has not been seriously undertaken by any adequately trained psychobiologist.

Admitting the impossibility of presenting a good account of the temperamental traits of the organism, we naturally have recourse to case studies as exhibits. Whatever else they may lack there is abundant variety. We shall begin with descriptions of affective behavior in the adult.

Of a female, presumably mature, which Vosmaer observed for about a month, it is reported:

So excellent was her disposition that she never showed the least trace of malice or of anger; one could place his hand in her mouth without fear. Her demeanor was somewhat melancholy, which was not surprising in view of all the other circumstances. She was fond of society without distinction of sex, only preferring those who cared for her from day to day, and who treated her kindly. Often when they retired and she found herself alone, she would throw herself to the ground, as though in an agony of despair, uttering the most lamentable cries, and tearing whatever linen she could lay hold on to pieces. Her keeper was accustomed at times to sit beside her on the

floor, and once in a while as though inviting him to be seated, she took hay from her bed and arranged it beside her. One day Vosmaer found him in a frightful situation. The animal, attached by a large chain to a long, vertical iron beam, had seized the man, and by holding him between her front and back feet, was pressing him erect and helpless against her chest. However being presented with a plate of strawberries, she descended to eat them, thus freeing the man. He told Vosmaer that he had been sitting near the animal, when she suddenly climbed on his knees and embraced him thus, without however doing him any harm, but had kept him for some time in this situation when Vosmaer had arrived at the crucial moment for his delivery. (1778, pp. 13-14, free translation.)

Confirmatory of Vosmaer's description is the account given by Schlegel and Müller (1839-44, p. 16) of a mature female received by them as a present from a native chief. The animal had been kept in captivity for some time and was thoroughly tame, gentle, and good-natured. Knauer (1915) reports on certain well-known performing orang-outans, some of which, although mature, continued to be tractable. It seems, however, that there is marked contrast between the affective behavior of the sexes, the female continuing gentle and tractable after achieving maturity, whereas the male is more likely to become dangerous. In illustration we shall cite one or two instances from the many available.

An old male, standing four feet in height, captured alive, although wounded, by Schlegel and Müller, was very wild and to his death continued unapproachable.

His penetrating sharp glance and wild features, indicated him to be a more than untractable animal. Moreover, the long rough hair of his head and the heavy red beard under the chin gave him a wild appearance. Add to all this his terrible strength, of which he sometimes made use in a violent way, whenever one would torment him with a stick. . . . Our large living animal was above all false and malicious in the highest degree. If one came somewhat near him, he would slowly raise himself with a heavy growl; stare with an almost fixed gaze at the point where the attack might be made; cautiously move one hand to an opening in the iron bars of his cage, and flinging his long arms upward usually toward the face of the aggressor, grasp all of a sudden and in a flash. . . . As for the rest, this animal was always uncommonly sad, phlegmatic and sluggish of temper. Whenever left alone and undisturbed he remained lying down. Only when eating or drinking did he sit up. (1839-44, pp. 20-22.)

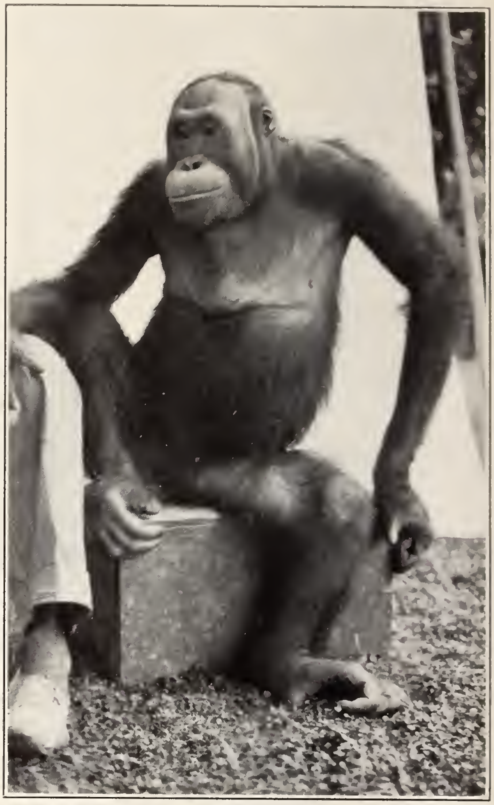


Fig. 62. The mature male orang-outan, Cachesita, aged about ten years, described by Yerkes, 1925. Courtesy of Harold C. Bingham, photographer, and Mrs. R. Abreu.

It may very well be claimed that this is the description of a mortally wounded specimen, for the authors state that he subsequently died extremely emaciated. On the other hand, there is abundant reason from observations made on uninjured specimens to believe that the unapproachableness of this old male is not exceptional, but instead may readily be matched. A striking contrast appears, however, when with the behavior of such captives one compares that of specimens reared from infancy or early childhood in proximity to man and in more or less close confinement.

From the Abreu primate colony in Cuba, Yerkes (1925, p. 55) has reported the be-

Fig. 63. Interest. Youthful female orang-outan and proboscis monkey. Courtesy G. Krause.

havior of a male orang-outan which had been resident in the colony for about six years and was judged to be not less than ten years old. He was thought to be sexually mature, but this may have been a mistaken inference from his size. Although he could at the time be handled by his keepers and was almost daily conducted from one cage or shelter to another, his owner did not fully trust him, and subsequent events demonstrated that her suspicion was well founded. Less than two years after the report referred to, this animal one day maliciously attacked the keeper who was leading him from his cage, and except for interference probably would have injured him seriously, if not fatally. Presumably his unfriendliness continued, for it was only a few months later that he met his death at the hands of a keeper who maintained that he struck in self-defense. This particular specimen must have been captured during early childhood and undoubtedly most of his life was spent in captivity and under excellent conditions. His sudden change of attitude toward man possibly accompanied the attainment of sexual maturity.

Contrasting the traits of young and old specimens, Schlegel and Müller emphasize the great differences which are related to individuality as well as to age. Although in five immature tame orang-outans nearly the same manners appeared:

> There were observed in each of them more peculiarities of character than in most other Quadrumana. The one individual is much more docile and gentle in nature than the other; some are very trusty and manifestly sensitive to caresses; others show themselves indifferent, sometimes stiff-necked and more or less false. Whereas two of our specimens, a male and a female, esti-

mated at ten to fourteen months of age, always acted as if afraid when threatened with punishment, a much younger male, on the contrary, could be controlled only by serious means, so that often he was threatened with a whip and sometimes it was used for painful chastising, against which he defended himself vigorously. The latter strove as it were to obtain through malevolence what another one by a sad expression, and a third by compassion-awakening lamentation seemed to desire and beg. . . . .

In like manner as the disposition of each orang-outan is marked by certain peculiarities, so also usually the physiognomy of each is characterized by peculiar features which even as in man attract attention at the first glance and from which the temperament of the animal may be read. (1839-44, pp. 22-23.)

Of an immature male orang-outan Grant (1828, p. 6) remarks that it was rather more lively than might be expected from the descriptions of most authors. "Though active, however, gravity and sedateness mark all his actions, and he has the air of a philosopher even when performing his somersets." Likewise Schmidt (1878), in an admirable account of the behavior of a young male, dwells on its playfulness, gentleness, friendliness, dependence, tricks, jokes, and other childlike traits of affective behavior.

Our own acquaintance with the orang-outan is limited to four captive specimens. The first, a male of approximately five years, used especially as subject for experimental studies in adaptation of behavior, was eminently childlike in his expressions of attachment to the observer, and has been characterized as gentle, docile, friendly (Yerkes, 1916, p. 63). By contrast with two females, probably between six and eight years of age and obviously nearing sexual maturity, the five-year-old male was markedly more active, energetic, and playful. And the contrast was yet more marked when the oldest of the four animals referred to above, a mature male, is compared with the three immature specimens.

Presumably there are certain primary temperamental or dispositional characteristics which endure with more or less modification throughout the life of the individual, knowledge and measurement of which would make possible useful description. Unfortunately we are ignorant in this matter and therefore incapable of doing more than tentatively to characterize the affective behavior of individuals and definitely to indicate informational deficiencies and unsolved problems. Evidently the subject demands, and is eminently worthy of, sustained attention.

We are following, in this chapter, the terminology of the ages, ignoring recent modifications of the concepts of instinct, intelligence, and their relations, and, for the sake of intelligibility, describing in an affective terminology which has existed for many generations the modes of orang-outan behavior which have been generally accepted as expressions of feeling, emotion, or sentiment. This does not necessarily imply acceptance of the meanings at various times given to the terms. Indeed, we are endeavoring to state facts of behavior without inference or implication with reference to subjective accompaniment.

EMOTIONAL PATTERNS

It is now in point to describe as well as may be the particular forms and modes of affective expression in the orang-outan as evidenced in the literature. To begin with acts of withdrawal and self-abnegation—it appears that by one or another observer behavior has been noted which is assumed to indicate modesty, shame, timidity, fear, terror. Rarely is such affective behavior described fully. More often it is merely named on the assumption presumably that there are typical behavior patterns or complexes for shame, fear, and other emotions. By this method of description, knowledge unfortunately has been advanced little if at all.

In a large female orang-outan exhibited in Calcutta, shame is thus referred to by Blyth:

A remarkable trait of this individual was her decided sense of *pudor:* however she might lie or roll about, she never failed to use one foot for purposes of concealment, holding therein a small piece of board generally, or in default of this a

wisp of straw, or whatever she could seize on for the purpose. (Blyth, 1847, p. 729, footnote.)

This is the only mention known to us of attempt by the orang-outan to cover or conceal the external genitalia. In the chimpanzee such behavior has several times been noted. In the absence of history of the act, the explanation or interpretation implied in the word shame is no better than a guess. The behavior in fact may be conditioned by prior internal or external stimulation, it may be response to immediate external or internal stimulation, or it may be protective or defensive. Modesty or shame may or may not be correlated with it. Without more detailed and precise knowledge of the nature, genesis, and conditions of the behavior it would be rash indeed to infer their existence.

Any unusual situation may induce in the orang-outan a behavioral set or attitude which suggests preparedness for withdrawal or self-protection. And although such attitudes, including incipient or pronounced avoidance reactions, are most conspicuous in immature individuals, they are not lacking in adults. As a fact, there are few accounts of the manners, habits, or psychological traits of orang-outans which do not supply instances of apprehensiveness, reserve, caution, and timidity. Instead, therefore, of citing authorities we shall here present two typical illustrative cases.

Readily verified by anyone who cares to test the matter is Grant's description of the behavior of an immature male orang-outan during anthropometric observations.

His restlessness rendered it difficult to take exact measurements of him. He appeared suspicious of such movements as he could not comprehend, being seemingly afraid that some injury might be inflicted upon him. Thus, when I wanted to take measurements of his head and body, he held the former down firmly, and crouched himself up into a ball. The poor fellow felt really afraid that some violence was going to be done him, and seized hold repeatedly of the tape with which I was measuring him. This he would retain in his hand until forcibly deprived of it; but when he became a little more familiar with me, he regained his self-possession, and permitted me to make my examinations with less trouble. (Grant, 1828, p. 11.)

Usually adaptation by young orang-outans to novel situations is fairly rapid, and apprehensiveness quickly gives place to interest, curiosity, exploration, and in such a situation as that described by Grant to actual coöperation with the observer.

Schmidt also offers description of characteristic affective behavior, the like of which we have frequently observed in orang-outans. For brevity we paraphrase his text.

When a dead sparrow was placed in the cage of a young orang-outan the latter approached and looked at it with mingled curiosity and anxiety, simultaneously drawn to it and repelled by it he evidently mistrusted the object. Gradually he approached it and carefully avoiding the feathers touched one of its feet. A moment later, with exacting care, he lifted the bird by one claw, but immediately as if apprehensive let it fall. Then bending over it he watched and as it did not move, picked it up and holding it near his face, as if nearsighted, examined it closely. Legs, feathers, head, were intently observed as he held the small body tightly in fear of losing it. In his extreme seriousness and intentness his face was comic. Presently, with evident expectation that the bird would move, he laid it on the ground. (Schmidt, 1878, p. 228.)

The numerous though meager records which we have been able to consult appear to indicate that timidity tends to diminish with age, but we cannot say that the fact is established.

Apprehensiveness readily passes into fear. It is as if the reaction spread to new mechanisms and simultaneously became more intense. Any unusual and, therefore, startling object or event may induce erection of the hair (Darwin, 1873, 2d ed. 1892, p. 101) and marked effort at avoidance or self-protection.

Again a few typical cases may be presented, for although there are many references to fear reactions, we have discovered

Fig. 64. Admonition. Orang-outan and proboscis monkey. Courtesy of G. Krause.

no single adequate description of this type of affective behavior.

Violent alarm, Abel says, was observed on two occasions in a young male orang-outan on shipboard.

> On seeing eight large turtle brought on board . . . he climbed with all possible speed to a higher part of the ship than he had ever before reached; and looking down upon them, projected his long lips into the form of a hog's snout, uttering at the same time a sound which might be described as between the croaking of a frog and the grunting of a pig. After some time he ventured to descend, but with great caution, peeping continually at the turtle, but could not be induced to approach within many yards of them. He ran to the same height and uttered the same sounds on seeing some men bathing and splashing in the sea; and since his arrival in England, has shown nearly the same degree of fear at the sight of a live tortoise. (Abel, 1818, p. 329.)

Fear of snakes, which many observers have described as instinctive in one or another type of primate, is reported in the orang-outan by Warwick and Mitchell. The former, writing of a female orang-outan and a male chimpanzee which were companions in captivity, says that the timidity of both animals was remarkable.

> They being exceedingly alarmed even at inanimate objects; a toy-dog, or a cast of one of their own species, that was in the room, if removed the least towards them, was sufficient to drive them to the farthest extremity of the apartment, in *their* most nimble, though not very quick, pace; and the fear exhibited by the female, at the sight of her deadly enemy, a boa constrictor, was most acutely evinced. It would appear as if they had not the power of distinguishing between the real and artificial, as a toy-snake shown to her produced the same results. (Warwick, 1832, p. 308.)

Granted that this author's assumptions are more obtrusive than his observations, it is highly regrettable that he did not see

fit to describe at least in its essential features the snake-avoiding behavior of his subjects.

Of peculiar interest and scientific value are the reactions of orang-outans to snakes observed by Mitchell under experimental conditions in the London Zoölogical Gardens.

> The panic in the presence of snakes was most sudden and complete in the case of orangs. When I tried the experiment, there were two unusually fine examples in the collection, one a large and probably adult male, the other a well-grown young female that had been two years in the Gardens and was very tame and gentle. Both of these animals were usually most deliberate in their movements, coming slowly across the cage even for their favourite food, and climbing as if it were too much trouble to move. But as soon as they caught sight of a snake and long before it was near them, they fled silently, but with the most unusual celerity, climbing as far out of reach as possible. (P. C. Mitchell, 1912, p. 201.)

Extraordinarily persistent is the religiously motivated belief or conviction that infrahuman animals must possess certain ready-to-hand or instinctive modes of response. Of this human superstition our insistent belief in an innate fear of snakes by monkeys and apes is a notable example. Probably complete knowledge of the genesis of snake-avoiding behavior in the orang-outan, or in any other primate, will definitely indicate its partial dependence upon the experience of the individual (P. C. Mitchell, 1922, p. 348). We should extend our comment to other patterns of response traditionally described as innate, for the evidence which has accumulated from the study of human and anthropoid behavior seems to indicate that in many if not all instances the behavior-pattern consists of a primary reactive tendency and capacity which through exercise and experience becomes elaborated until it is highly adapted. Also our experience as students of animal behavior suggests this working hypothesis instead of the assumption that certain elaborated patterns are inherited as such and are practically independent of experience. Dogmatism is not in order, but open-mindedness and willingness to search diligently for facts assuredly are much to be desired.

Descriptions of extreme forms of avoiding behavior, as in terror, are lacking for the orang-outan, and the behavioral picture of fear is inadequately sketched. Suggestive of problems, but also indicating additional modes of affective expression, is a contribution of Deniker, who in commenting on emotional expressions remarks:

> According to my observations the orang did not have the habit of projecting his lips. When excited or irritated, he opens his mouth and displays his great, clenched teeth, at the same time showing a minute movement of the middle of the upper lip, raised by the action of the canine muscle; it was this movement, characteristic of anger or defiance among many of the animals, which was so well studied by Darwin. (Deniker, 1882, p. 337.)

Self-advancing, aggressive behavior as implied by the terms impatience, resentment, anger, rage, is not lacking in the orang-outan, and although we have discovered no adequate account of such affective activity, several significant features or aspects are mentioned by one or another observer.

The following expressions of impatience or resentment are noted by Grant, who, in describing the activities of an orang-outan which had just enjoyed some tea, writes:

> He solicited with all the mute eloquence in his power for more tea. Some cold water was put into his saucer, but he was not to be so imposed upon; he poured it angrily out on the floor, (taking care, however, not to break the saucer,) whined in a peculiar manner, and threw himself passionately on his back on the ground, striking his breast and paunch with his palms, and giving a kind of reiterated *croak*. This action he repeated several times, giving himself very heavy falls on the back of his head and spine, striking against the floor with a violence which could not have failed, I should suppose, to hurt a human being, but which appeared to give him no pain whatever. (Grant, 1828, p. 11.)

Analogous acts are reported of a young male orang-outan by Yerkes (1916, p. 81). When unable to succeed in problems which were set for him, this subject at times would strike his head repeatedly against

Fig. 65. Discipline. Orang-outan and proboscis monkey, both in their childhood. Courtesy of G. Krause.

the floor, or again he would turn either a single somersault or a series of them in rapid succession. Similar behavior has been recorded for human subjects.

Almost certainly such acts when exhibited by orang-outan or man indicate strong desire for some objective and a measure of impatience or anger. The "temper tantrum" is easily evoked in the infantile or childish orang-outan. It has been noted by many authors and described by a few, among whom are Grant (1828), Rennie (1838), Hornaday (1879), Shelford (1916). As observed by us this type of affective behavior is essentially like that of the uninhibited child, for the animal when sufficiently provoked screams, casts itself on the ground, and there flings itself about with abandon, careless it would seem of discomfort or minor hurts, and intent only on self-determination. There can be no doubt that this affective display is commonly employed by young orang-outans as a means of achieving their desires. This interpretation finds expression in the following quotation from Cuvier.

> I have frequently seen it testify its impatience in this way [temper tantrum]: when any thing was refused it which it wanted, not being able or not daring to attack those who opposed its wishes, it would throw itself on the floor, strike its head, and thereby endeavour to excite interest or pity in a more lively manner. This method of expressing sorrow or anger is not observable in any animal, man excepted. Was this ourang outang led to act in this manner from the same motives which actuate us in similar circumstances? I am inclined to answer this question in the affirmative: for in its passion it would occasionally raise its head from the ground and suspend its cries, in order to see if it had produced any effect on the people around, and if they were disposed to yield to its entreaties: when it thought there was nothing favourable in their looks or gestures, it began crying again. (F. Cuvier, 1811, pp. 196-197.)

Abel cites what he suspects to be a case of threatened suicide in connection with temper tantrums.

> But although so gentle when not exceedingly irritated, the orang-outang could be excited to violent rage, which he expressed by opening his mouth, showing his teeth, seizing and biting those who were near him. Sometimes indeed he seemed to be almost driven to desperation; and on two or three occasions committed an act, which, in a rational being, would have been called the threatening of suicide. If repeatedly refused an orange when he attempted to take it, he would shriek violently and swing furiously about the ropes; then return and endeavour to obtain it; if again refused, he would roll for some time like an angry child upon the deck, uttering the most piercing screams; and then suddenly starting up, rush furiously over the side of the ship, and disappear. On first witnessing this act, we thought that he had thrown himself into the sea; but on a search being made, found him concealed under the chains. (Abel, 1818, pp. 328-329.)

That modes of affective expression vary extremely with age, sex, and individuality is established. Certain of the possibilities of variation are suggested by comment of Delisle (1893, pp. 648-649) on the facial expressions of Maurice and Max, the adult male captives in Paris. (See figs. 53, 54, p. 133.)

> Maurice had enormous cheek pads, the appearance of which varied with the light and his affective condition. When he was calm they appeared dull, but when he became excited they reflected much light, while at the same time his eyes looked "menacing and wicked." Also in excitement the laryngeal sacs might be inflated and the teeth exposed. In Max, a younger animal, the cheek pads and laryngeal sacs were smaller and consequently played a quite different rôle in facial expression.

By Schlegel and Müller, Wallace, Hornaday, and other hunter-collector-naturalists, behavior in wounded orang-outans indicative probably of mingled terror and rage, is reported. In particular, old males, when seriously wounded or compelled to fight for their lives, may scream, roar, tear the jungle vegetation, break off limbs of trees, and otherwise act as though maddened by pain and at once enraged and terrorized. Ordinarily such extreme expressions would not be seen in captives. From various observers we have gleaned the information for a composite picture of the enraged adult male. With muscles tense, hair erect and bristling, jaws parted and lips drawn exposing formidable teeth, laryngeal sacs inflated, cheek pads tense and shining, beady eyes glittering, and uttering loud screams or roars, the animal may hurl himself upon an adversary. It is not a sight to calm timid ones or to convince the skeptic that the orang-outan is harmless.

Expressions of contentment, satisfaction, pleasure, delight, joy, have been mentioned frequently, but very imperfectly described. Particularly during early life, although also occasionally in maturity, playfulness appears, and in connection therewith varied evidences of physical well-being and joy in activity and social relations.

A characteristic behavioral picture of joy has not been drawn. No one it seems has observed it with sufficient patience, skill, and objectivity to describe even the facial changes, still less the bodily attitude and physiological conditions. It is a task worthy the attention of a first-rate observer.

Often in play with their fellows or with persons, and when chased, mauled, or tickled, young orang-outans chuckle, grunt, gurgle, and exhibit distortion of facial features which might readily be taken, or mayhap mistaken, for smiling or laughter.

> Although the beautiful play of the features which we call smiling is confined to man alone, yet is the orang-outang capable of a kind of laugh when pleasantly excited. For instance, if tickled, the corners of his mouth draw up into a grin; he shows his teeth, and the diaphragm is thrown into action, and reiterated grunting sounds, somewhat analogous to laughter, are emitted by the animal. The creature indeed is extremely sensible to tickling in those parts where a human being is, as the armpits and sides. (Grant, 1828, p. 4.)

As footnote to the publication of Grant appears this comment by one Montgomerie, owner of the orang-outan observed.

> I have observed in this individual, and also in a young female which was in my possession for twelve months, when not excited by any apparent cause, a contraction of the upper lip, showing the

teeth, and a play of the features resembling a smile, as if excited by some pleasant idea. She also when tickled (withholding her breath and struggling) would utter a half-suppressed sound, which might be expressed by the letters *Khee,* much in the same way as some individuals of the human species when placed under similar excitement.—Note by Mr. M. (Grant, 1828, p. 4.)

Although smiles and laughter are mentioned by several observers of orang-outan behavior, no one has critically discussed the legitimacy of the terms. If they imply a sense of humor one might hesitate to apply them. Yet the abundant evidence of tricks, jokes, and intent to surprise, tease, or otherwise disconcert their ape or human companions would suggest even humor. Possibly it would be as much like quibbling to object to the use of the term laughter as of feeling. Probably most open-minded observers would unhesitatingly say either: I believe that the animals smile or laugh because I have seen them do so, or, I do not believe it because I have not seen it.

The lips are conspicuously expressive because of their extreme mobility and constant use. They seem to play a far more important rôle in this respect in orang-outan and chimpanzee than in gibbon, gorilla, or man. From our own observations we should conclude that in contentment or delight they are protruded slightly if at all, and they may be held firmly together or parted in less or greater degree; but in impatience or resentment, in begging or mute appeal, they commonly are protruded in funnel shape as if to facilitate the peculiar vocalization characteristic of these attitudes. As resentment gives place to anger or rage they may be protruded extremely in accompaniment with loud screaming, or the mouth may be opened widely and the lips drawn back. Undoubtedly in all such emotional conditions marked play of feature occurs; yet no description of it is available. Truly there is much to see, much to measure, much to describe, correlate, and explain in orang-outan affective behavior whether or not feeling, emotion, mood, or sentiment be present.

Among the best available descriptions of affective expressions in the young orang-outan are those of Schmidt (1878). This observer was especially impressed by the variation in facial expression and in bodily attitude. His descriptions indicate that his subject was very active and responsive. Indeed, it would appear to have been much more so than the typical specimen. An explanation of this may possibly appear in the fact that it was companion to a chimpanzee. Possibly the social stimulus resulting from the presence of this more active and expressive ape stirred the orang-outan to more frequent and more pronounced affective behavior.

The so-called tender emotions are slightly in evidence. Attraction apart from the sexual, filial, or parental is noted most frequently as between or among companions in captivity or orang-outan and human friend or caretaker. Attachments are common within the species and also for human friends, and there are numerous expressions of appreciation and gratitude.

Seldom does one meet in the orang-outan literature the words sympathy and love. Respecting this mode of experience and expression F. Cuvier writes thus illuminatingly and, we believe, correctly.

We have already seen that one of the principal wants of our ourang outang was to live in society, and to attach itself to persons who treated it with kindness. For M. Decaen it had a particular affection, of which it gave daily proofs. One morning it entered his apartment while he was still in bed, and threw itself upon him embracing him strongly, and applying its lips to his breast, which it sucked as it used to do his fingers. On another occasion it gave him a still stronger proof of its attachment. It was accustomed to come to him at meal times, which it knew very well, in expectation of victuals. With this view it leapt up behind his chair, and perched upon the back of it; when he gave it what he thought proper. On his arrival in Spain, M. Decaen went ashore, and another officer of the ship supplied his place at table: the ourang outang placed itself on the back of the chair as usual; but as soon as it perceived a stranger in its master's place it refused all food, threw itself on the floor, and rolled about in great distress, frequently striking its head and moaning bitterly. (F. Cuvier, 1811, p. 196.)

We are able to confirm from our own

experience with immature orang-outans the use of affective behavior as means to a definite end and we therefore agree that it may be partially assumed or pretended emotion.

Of the kiss as sign of attachment Abel remarks:

> Some writer states, that an orang-outang which he describes gave "real kisses"; and so words his statement, that the reader supposes them the natural act of the animal. This is certainly not the case with the orang-outang which I have described. He imitates the act of kissing by projecting his lips against the face of his keeper, but gives them no impulse. He never attempted this action on board ship, but has been taught it by those who now have him in charge. (Abel, 1818, pp. 329-330.)

Although kissing, so called, has many times been described in both the orang-outan and chimpanzee, we have discovered no proof that it is natural to these anthropoid apes. Instead, as Abel infers, it may be either an imitation of man or response to his direction or command.

Of sympathy, mutual aid, or coöperation in family or species there are almost no trustworthy records. Undoubtedly reliable information is difficult to obtain. Yet such study as has been made of free and captive orang-outans, and especially the knowledge we have thus acquired concerning their relative unsociability, render it highly probable that they are only slightly sympathetic and altruistic in their expressions. The accounts of hunter-collectors indicate that they may on occasion attempt to protect or defend their young, but whether this extends to adult members of the family or other social group is not certainly known.

From our observation of a mature male and two half-grown female orang-outans which were companions in captivity in the Abreu primate colony at Havana, we gleaned evidence of playful social relations but scant indication of anything approaching altruistic interest. And from our search of the literature we have learned next to nothing. We must, therefore, believe that the scientist who undertakes to study sympathetic relations and activities in this ape will have the advantages of a virgin field of inquiry, and one also of peculiar interest and significance for students of social phenomena.

Although indications of depression, sadness, and grief are not wanting, here also useful descriptions are lacking. Since naturally the orang-outan tends to quiescence and serious mien, it is inevitably characterized as melancholy in appearance, and indeed, except for moments in infancy and childhood when the joy of living seems to possess it, it behaves as though depressed. There are, however, depths and degrees of depression, and it is possible by various means to induce even more marked expression of sadness or grief than the ordinary. In disappointment the young specimen quite commonly whimpers or weeps, without, however, shedding tears. Only casual references to such affective behavior have been found and they contribute little and uncertainly to our knowledge. (Hermes, 1876; Schmidt, 1878, p. 198.)

Were information adequate to the need, we should attempt as a matter of course to enumerate the various factors in affective behavior and the conditions which primarily influence them, for after all, as they act orang-outans are to us, and our descriptions of behavior will remain unsatisfactory as long as its affective aspects are ignored, neglected, or only casually considered.

VOCALIZATION

In only one direction has the general subject of affective expression received better than passing and incidental notice; that is, vocalization and speech. And even in this instance the motivation of inquiry was initially religious, springing from the demand and desire for proof that on structural grounds it is impossible for the anthropoid ape to talk. Not the disinterested thirst for knowledge, curiosity about natural facts, and desire to understand, so much lauded by patrons and admirers of scientific research, but instead defensive reaction focused human attention on the vocal mecha-

nism of the orang-outan and its exercise. Thanks to this impulsion we now know something at least of the phenomenon of vocalization, which is more than can be said for most aspects of affective behavior.

Notably a silent creature, the orang-outan seldom in captivity, and perhaps even as rarely in nature, produces sounds. The vocal mechanism of the creature early drew the attention of Camper, who examined by dissection both the larynx and the laryngeal sacs. Noting that many travelers, while admitting that the ape does not speak, think that it could if it would, he says, "My principal study in this essay will be to prove the absolute impossibility there is for the Orang and other monkies to speak." (Camper, 1779a, p. 140.)

Already, on page 24, we have quoted Camper's conclusions, which it is not surprising to discover conform to his initial bias and in his judgment demonstrate the "impossibility" which he predicted. It is not our task to review or evaluate this able investigator's morphological findings, and it must suffice to remark that competent anatomists have praised his observations and descriptions.

For summary accounts of the comparative anatomy of the larynx and laryngeal sacs and for bibliography, reference may be made to Keith (1896, p. 320), Sonntag (1924, pp. 257 ff.), and our page 106. Apparently it is well established that the laryngeal sacs function in connection with vocalization.

Of obvious psychobiological interest in connection with vocalization is a study by Grünbaum and Sherrington of the physiology of the cerebral cortex in which the orang-outan and chimpanzee were used as subjects. In reporting the results of faradization of the cortex these investigators state that strong stimulation of certain points induced movements in the larynx distinguishable from the respiratory rhythm.

> Judging from such evidence as we altogether obtained, we conclude that either (1) no Broca "speech centre," at all distantly foreshadowing the human, exists in these anthropoid brains, or (2) that direct faradisation of the Broca speech cortex is inefficient itself to evoke vocalisation. These two inferences, are, of course, not mutually exclusive, and both the suppositions may be correct. (Grünbaum and Sherrington, 1903, p. 152.)

From a position which in important respects is diametrically opposite to that of Camper, Monboddo examined the characteristics of the anthropoid apes in their relations to those of man. Obviously he was committed to the unity of the primates and sought in all facts evidence of the intimate relation of man and ape. Briefly put, it is his thesis that the orang-outans (used as inclusive of the chimpanzee) are classifiable as men, that the possession of speech, one of Buffon's criteria for humanity, is false, and that because orang-outans do not speak one cannot safely assume that they are incapable of it.

Since Monboddo's arguments are ingenious, we shall quote him, despite the fact that his materials are entirely secondhand and many of them of uncertain value.

> But I think I have proved the direct contrary [that man lacks natural power of speech]; and have shown evidently, by arguments, both *a priori* and *a posteriori,* that there is no natural language belonging to man, except what belongs to other animals; and all that may be truly said of man is, that he has the capacity of acquiring the faculty of speech, as well as many other faculties, which he has added to his nature. If, therefore, any thing concerning speech were to be added to the definition of man, it should be mentioned in the same way as *intellect* and *science* are in the Peripatetic definition; and we should say, that man is an animal *capable* of *speech.* Now, that the Orang Outang has this capacity, we cannot reasonably doubt, when we see, that he has the capacity of being a musician, and has actually learned to play upon the pipe and harp, a fact attested, not by a common traveller, but by a man of science, Mr. Peiresc, and who relates it not as a hearsay, but as a fact consisting with his knowledge. And this is the more to be attended to, as it shows, that the Orang Outang has a perception of numbers, measure, and melody, which has always been accounted peculiar to our species. But the learning to speak, as well as the learning music, must depend upon particular circumstances; and it shall be shewn, in the sequel, that men, living as the Orang Outangs do, upon the natural fruits of the earth, with few or no arts, are not in a situation that is

proper for the invention of language. The Orang Outangs, who played upon the pipe, had certainly not invented this art in the woods; but they had learned it from the negroes or the Europeans; and that they had not at the same time learned to speak, may be accounted for in one or other of two ways;—either the same pains had not been taken to teach them articulation; or, secondly, music is more natural to man, and more easily acquired than even speech, and was probably, as shall be afterwards shewn, first learned by them.

The objection, therefore, when thoroughly examined, comes to this, that the Orang Outang has not yet learned the several arts that we practise; and among others which he has not acquired, is that of Language. If, on this account, the Orang Outang be not a man, then those philosophers of Europe, who, about the time of the discovery of America, maintained, that the inhabitants of that part of the world were not men, reasoned well; for, certainly, the Americans had not then, nor have they yet, learned all the arts of which their nature is capable. . . . (Monboddo, 1773, I, 347.)

In the foregoing references to affective expressions and descriptions of various types of affective behavior, several forms of vocalization have been mentioned. We shall now briefly review them by enumeration, with occasional reference to an original authority.

According to Vosmaer, his orang-outan subject was not heard to utter any sound except when alone, and then its vocalization initially resembled the howling of a young dog and later the harsh grating noise of a saw passing through wood (Vosmaer, 1778, p. 18). By Schlegel and Müller (1839-44) passing reference is made to the "grumbling sound" by which at night the presence of orang-outans in a region becomes known. In wounded specimens they describe shrill screaming and a deep roar or bellow not unlike that of the panther. Further, these authors state that during the scream the lips are protruded in funnel shape, whereas for the roar the mouth is opened wide and the laryngeal sacs are inflated. Temminck (1835-41), doubtless deriving his facts from Schlegel and Müller, mentions the buzzing or humming sound produced by captive or wounded adults. But as we interpret his description this is a quality of the scream and not a separate vocalization. Whimpering, crying, grunting, chuckling, and screaming, all are mentioned by Schmidt (1878) in his account of the behavior of a four-year-old captive. This authority surmises that mature animals may make louder sounds than the young because of possession of laryngeal sacs. And in this connection it should be noted that Priemel (1908, p. 81) especially remarks the development of laryngeal sacs in a female orang-outan at about the sixth year. Presumably this means that they were first observed at that time or possibly that they then became functional. The voice of this animal, the author tells us, was seldom heard, yet in response to tickling she would utter a shrieking squeal. Shelford (1916, pp. 4-5) also emphasizes the silence of the animal and remarks that it occasionally produces grunting sounds and that the young ones may scream and yell like naughty or angry children.

Probably this is a very incomplete list of orang-outan sounds, and certainly as description of vocalization it is almost ludicrously inadequate. Nevertheless it accurately represents the present status of knowledge.

SPEECH

Speech or language as contrasted with vocalization has attracted the attention of only a few students of this great ape. We have already cited the bias of Monboddo as contrasted with that of Camper and have quoted each in order to exhibit the futility of scientific effort which is directed toward the support of a conviction instead of the discovery of nature's facts.

It is entertaining in this connection, and not without scientific significance, that one of the very best of natural histories of the apes should attempt to resolve the problem of orang-outan speech much as the present-day psychophysiologist might be expected to, prior to detailed and accurate knowledge of the facts. We permit Rennie to speak for himself.

There is another character in the organization

of the orang-outan, which it is necessary that we should briefly explain, since it has been supposed by many excellent anatomists, to be the principal, if not the only impediment that prevents this animal from uttering articulate sounds, and, in fact, from speaking as well, or nearly as well, as ourselves. That this idea is altogether gratuitous and unfounded might be very readily demonstrated; it were easy to show that the faculty of speech is peculiar to man, not so much on account of the perfection of his organic structure, as of the superior constitution of his mind, and especially of that power of abstraction and generalization which he alone enjoys, and by which he is enabled to make his words the signs and interpreters of his thoughts. We shall not enter upon this purely metaphysical investigation at present; but it is at least due to the talents of the celebrated men who have promulgated these opinions, to examine what they are, and particularly as the structure in question, though unconnected with the faculty of speech, is no doubt an important agent in other parts of the animal's economy. (Rennie, 1838, p. 87.)

To a surprising number of biologists as well as laymen, speech in monkeys or apes suggests the name Garner, and if in this chapter we fail to mention his name it might be considered an inexcusable oversight. The fact is that although Garner devoted a considerable part of his life to the intensive study of vocalization and speech in the infrahuman primates, his publications indicate serious lack of scientific competence. It is not on this score, however, that we would justify omission of reference to him in any discussion of speech in the orang-outan. We quote from one of his books a paragraph which leaves nothing for us to add. It happens that this same paragraph appears almost verbatim in a later book.

I have never had an opportunity of studying this ape in a wild state, and have only had access to four of them in captivity, all of which were young and most of them inferior specimens. He is the most obtuse or stupid of the four great apes. And were it not for his skeleton alone he would be assigned a place below the gibbon, for in point of speech and mental calibre he is far inferior. The best authorities perhaps upon the habits of this ape in a wild state are Messrs. W. T. Horniday and R. A. Wallace. (Garner, 1896, p. 260.)

We beg to make corrections in this paragraph as follows: Horniday should be spelled Hornaday, and the initials of Wallace are A. R. instead of the reverse. The only single point in which we can agree with Garner is that he never studied the orang-outan.

Aside from such speculative discussions of anthropoid speech as are exemplified by those of Monboddo, the only special contribution to the subject is that of Furness. We shall quote him at length because of this fact, and also on account of the extraordinarily interesting character of his observations.

Referring to the orang-outan and chimpanzee, Furness writes:

If these animals have a language it is restricted to a very few sounds of a general emotional signification. Articulate speech they have none and communication with one another is accomplished by vocal sounds to no greater extent than it is by dogs, with a growl, a whine, or a bark. They are, however, capable to a surprising degree of acquiring an understanding of human speech.

In the case of the orang-utan it took at least six months of daily training to teach her to say "Papa." This word was selected not only because it is a very primitive sound, but also because it combined two elements of vocalization to which orang-utans and chimpanzees are, as I have said, unaccustomed, namely: the use of lips and an expired vowel sound. The training consisted of a repetition of the sounds for minutes at a time, while the ape's lips were brought together and opened in imitation of the movements of my lips. I also went through these same maneuvers facing a mirror with her face close to mine that she might see what her lips were to do as well as feel the movement of them. At the end of about six months, one day of her own accord, out of lesson time, she said "Papa" quite distinctly and repeated it on command. Of course, I praised and petted her enthusiastically; she never forgot it after that and finally recognized it as my name. When asked "Where is Papa?" she would at once point to me or pat me on the shoulder. One warm summer's day I carried her in my arms into a swimming pool; she was alarmed at first but when the water came up to her legs she was panic stricken; she clung with her arms about my neck; kissed me again and again and kept saying "Papa! Papa! Papa!" Of course, I went no further after that pathetic appeal.

The next word I attempted to teach her to say was "cup." (Let me say that by this time she understood almost everything that it was necessary for me to say such as "Open your mouth," "Stick out your tongue," "Do this," etc., and she

was perfectly gentle and occasionally seemed quite interested.) The first move in teaching her to say cup was to push her tongue back in her throat as if she were to make the sound "ka." This was done by means of a bone spatula with which I pressed lightly on the center of her tongue. When I saw that she had taken a full breath I placed my finger over her nose to make her try to breathe through her mouth. The spatula was then quickly withdrawn and inevitably she made the sound "ka." All the while facing her I held my mouth open with my tongue in the same position as hers so that her observation, curiosity, and powers of imitation might aid her, and I said *ka* with her emphatically as I released her tongue. After several lessons of, perhaps, fifteen minutes of this sort of training each day she would draw back her tongue to the position even before the spatula had touched it, but she would not say *ka* unless I placed my finger over her nose. The next advance was that she herself placed my finger over her nose and then said *ka* without any use of the spatula; then she found that in default of my finger her own would answer the purpose and I could get her to make this sound any time I asked her to. It was comparatively very easy from this to teach her to say "*kap*" by means of closing her lips with my fingers the instant she said *ka*. At the same time I showed her the cup that she drank out of and I repeated the word several times as I touched it to her lips. After a few lessons when I showed her the cup and asked "What is this?" she would say cup very plainly. Once when ill at night she leaned out of her hammock and said "cup, cup, cup," which I naturally understood to mean that she was thirsty and which proved to be the case. I think this showed fairly conclusively that there was a glimmering idea of the connection of the word with the object and with her desire.

By getting her to stick out her tongue and then by holding the tip of it up against her teeth and at the same time forcing her to breathe through her mouth I finally got her to make the sound *Th*. This was preliminary to teaching the words: the, this, that.

All this was encouraging I will admit but then —"I never nursed a dear gazelle . . .," etc.; the poor little animal died four or five months after this first tiny inkling of language. (Furness, 1916, pp. 283-285.)

It is appropriate to conclude this chapter with the words of Furness. They leave us with the impression that we have certain fragmentary information about the affective behavior of the orang-outan. True, this feeling may be somewhat illusory, and certainly our ignorance is relatively more impressive than our knowledge. We write this not in apology for the shortcomings of this chapter, nor yet in criticism of the scores of observers who have contributed the materials which have entered into it, but instead as motivating plea for more determined, sustained, systematic, and intelligent attention to the subject.

CHAPTER FOURTEEN

NERVOUS SYSTEM AND RECEPTIVITY OF ORANG-OUTAN

THE NERVOUS SYSTEM

FEW problems more intensely and generally interest inquiring man than the presence and nature of mind in other animals. But despite this almost universal interest, endless speculation and discussion, and not a little rather ill-conceived and poorly directed observational effort, slight progress has been made toward knowledge and understanding of mind in the orang-outan, or any other of the anthropoid apes. Because of this fact we are tempted beyond our resistance to quote certain sentences from Wurmb's famous description of a great orang-outan.

> The greatest vacuity which appears to us in the plan of nature is, certainly, that observed between man, a being endowed with reason, and the irrational animals. Naturalists hitherto have endeavoured, but in vain, by the most accurate researches to acquire some satisfaction on this point; and we may almost consider it as certain that the links of the great chain, here wanting, are not to be found in the world which we at present inhabit. Were nothing more required but similarity of bodily conformation, this transition, without doubt, would be found in the four-handed race of apes. But as the qualities of the mind are here as much considered as the form of the body, it is evident that the ape, which does not deserve the second rank among the irrational animals, cannot form the link that connects quadrupeds with man. The external figure, however, of this animal has since the earliest periods engaged the attention of naturalists; and by the similitude of its body we are led to suspect a similitude of mental powers in beings to which the all-wise Creator has given so much likeness. But as the discoveries made by the searchers into nature are frequently not so much the truth as something suited to the systems which they have adopted, this circumstance has given rise to a great deal of error. (Wurmb, 1798, pp. 225-226.)

If the eminent Dutch anatomist could return to examine our present psychobiological knowledge he probably would take more encouragement from it than do we, and it is not unlikely that he would be more hopeful of progress than most existing physiologists and psychologists appear to be. As for ourselves, admitting the paucity of definite information and the nearly complete dearth of insight, we are nevertheless optimistic. In fact, this survey and inventory of anthropoid lore is being made in preparation for an anticipated era of active study of the manlike apes, from which we confidently predict a rich harvest of fact and understanding. By such reflections as these we would fortify ourselves and the reader against the dismal prospect of ignorance anent orang-outan receptivity and adaptivity which this chapter must present. The precept which we have drawn from our study of the literature on the orang-outan is: Look backward with historical interest, appreciatively, understandingly, charitably; then look forward with constructive intent, enthusiastically, determinedly, expectant of unprecedented progress. But if so constituted that you must look in only one direction, let it be forward.

Psychobiological and neurological events cannot safely and profitably be dissociated. Therefore, we preface our survey of receptivity and adaptivity in the orang-outan by summary statement concerning the nervous system.

A century ago Tiedemann was at considerable pains to examine the orang-outan brain and to describe it in comparison with that of man. His materials were meager, his methods inferior to those of our day, yet his behavioral grounds of inference no less than his morphological descriptions continue to be significant. Glancing over his psychobiological data, some of which we now know to be incorrect, we note that he believed the orang-outan to be much more gentle, docile, affectionate, readily

trained and taught tricks or new ways of life than the other monkeys and apes. From this he inferred psychic abilities superior to those of other apes. With evident confidence he points out that the marked resemblance of the orang-outan brain to that of man is consonant with observed behavior and inferred experience. Differences as well as likenesses between orang-outan and human brain are enumerated by Tiedemann, and from their sum he concludes that since the cerebral hemispheres of the former are, relative to nerves, spinal cord, and all subordinate structures, much smaller than in man, and since in this proportionately lesser size and in the fewer furrows and convolutions of the brain appear the chief differences, it is conclusively established that the cerebral hemispheres are to be considered the workshops through which the intellectual operations are carried on. Primarily through size, volume, and structure of the cerebrum is man distinguished from all other animals. (Tiedemann, 1827.)

Evidently this author was strongly impressed by the marked similarity between human and orang-outan brains. We, however, suspect that the brain of the chimpanzee or gorilla would have served him at least as well as that of the orang-outan, and that his comparisons are between monkey and orang-outan and orang-outan and man rather than between orang-outan and other anthropoid apes.

The trend of Tiedemann's comparisons reappears in Owen (1865, p. 42) and in Mivart's *Man and Apes,* in which is written:

> The Orang is most like man in (1) the development of the beard in the males; (2) in the development of the styloid process; (3) in the length of the leg and foot taken together compared with that of the backbone; (4) in the length of the crest of the ilium; (5) in the development of the spine of the ischium; (6) in the length of the foot compared with that of the hand; (7) in the relative height of the cerebrum; (8) in the large proportion of its frontal lobe; (9) in the small proportion of its occipital lobe; (10) in the development of the "bridging convolutions"; (11) in the characters of the tongue; (12) in the high and rounded form of the skull. (Mivart, 1873, pp. 164-165.)

Supporting these comparisons is the relation of orang-outan cerebral coefficient to that of man, chimpanzee, gorilla, and gibbon, as taken from Mollison (1914-15, p. 394): Man, 30.4; Orang-outan, 10.5; Chimpanzee, 8.9; Gorilla, 8.4; Gibbon, 7.2.

Relatively less emphasis is placed by more recent writers on the closer resemblance of orang-outan than other anthropoid brains to the human, and one naturally doubts whether as between anthropoid apes and man structural differences are not more significant than any single measure of resemblance. There is a human tendency to seek such simple comparative statements as, the gorilla is more like man structurally than any other anthropoid ape; or, the gorilla is more intelligent than the orang-outan. It is conceivable that neither the affirmative nor the negative of such propositions is necessarily true and that accurate observation will presently compel us to particularize description instead of attempting to average morphological or behavioral phenomena. We may even be permitted to imagine, in the absence of information to the contrary, that the central nervous system of the orang-outan in general is neither more nor less like that of man than is that of the chimpanzee or gorilla, but that it possesses, along with resemblances and differences, distinctive peculiarities which at present we have no basis for evaluating or for comparing with the characteristics of other primate nervous systems. No small embarrassment results when a scientist permits such simple and almost inevitably misleading statements as we have cited to be dragged from him for popular enlightenment, entertainment, or other end. In fine, we do not believe that the brain of the orang-outan has been proved to be structurally or functionally more like that of man than is that of the chimpanzee or gorilla, but we are prepared to be shown.

Since these paragraphs were written, *The Brain from Ape to Man* by Tilney ap-

peared. In it (1928, II, 479 ff.) we discover strong support for our suspicion that orang-outan is not more manlike neurologically than are chimpanzee and gorilla. In fact, Tilney, although recognizing the striking configurational resemblance of its brain to that of man, ranks it as neurologically more primitive than either chimpanzee or gorilla. For more detailed authoritative information the reader is referred to Tilney's volumes.

Further, on the structural and functional neurology of orang-outan, we would cite as important: Rolleston (1861), Bischoff (1876), Beevor and Horsley (1890), Luna (1911), Leyton and Sherrington (1917), Sonntag (1924a), and more particularly as bibliographic sources, Keith (1895, 1896) and Sonntag (1924).

ORGANS OF SENSE

With this brief and inadequate characterization of the status of knowledge and inquiry concerning the central nervous system of the orang-outan we shall turn to examination of data on the receptors or sense organs. Again as bibliographic sources we would refer to Keith (1896) and Sonntag (1924). In the handbook of Sonntag, under the topic "sense organs," appears brief reference to the organs of touch, the eye and its appendages, and the organ of hearing in the anthropoid apes. Relative to the orang-outan there is scant information and no indication that any of its types of receptor have been studied intensively and described minutely and accurately.

Superficially at least, both the eye and the ear appear strikingly like the corresponding human organs. For neither is complete general and histological description available (see Sonntag, 1924, pp. 315-317; 1924a, pp. 435-438).

Cutaneous receptors for touch, pressure, warmth, cold, and pain, appear to be known only through the work of Kollman who has described touch balls in the hand and foot of anthropoid apes and man. In hands and feet of the three manlike apes touch balls of three orders are said to exist. In infrahuman primates touch balls of the first order are supposedly the important receptors for contact or pressure; the anthropoid apes differ from the monkeys in the form in which these balls occur, and also in the form of the balls of the second order. On the contrary, in the balls of the third order all of the monkeys and apes are more or less alike. In these cutaneous structures there is noteworthy difference between man and apes, the anthropoid apes exhibiting a structure much more like that of man than like that of the monkeys, especially in balls of the first order.

The relation between the peripheral nervous system and these manifold external structures, we are informed, can only be inferred on analogy from the hand. It may be assumed that the touch balls of the foot are more richly supplied with sensitive apparatus than are surrounding tissues (Kollmann, 1885).

The presence of papillae, some of which presumably carry "taste buds," in the tongue of the orang-outan is reported by Mayer (1843), and by several other observers whose publications are cited by Sonntag (1921). In the following respects the orang-outan tongue is said to resemble that of man: General proportions, rounded apex, V-type of vallate papillae, absence of long conicle papillae on the base, frenum linguae, small proportions of the fimbriate plicae, nature of the sublingual fold, and presence of apical gland of Nuhn. In all of these particulars it differs from the tongue of the chimpanzee and gorilla, and it therefore is next to man in order of resemblance (Sonntag, 1921, p. 17).

Complete dissection of the nasal structures of an orang-outan is described by Zuckerkandl, who states that in place of the olfactory cushions of the gibbons there occurs in the orang-outan a large smooth bony plate, running out into a point behind. There is no such histological description of the receptive mechanism as the psychobiologist might naturally desire

(Zuckerkandl, 1887). See also Seydel (1891).

Almost incredibly little is known of the sense organs of this great ape. There is not even a list of the types or classes of receptor. Presumably the animals are responsive to most of the stimuli which affect man; yet for this inference adequate morphological basis is wanting. Chiefly because of this dearth of information where the psychobiologist might naturally have counted on serviceable descriptions, we have in this chapter departed farther than usual from our rule against the inclusion of structural data.

RECEPTIVITY: MODES OF SENSE

REGARDING the modes and characteristics of receptivity in the orang-outan meager structural basis for inference appears. What, then, of contributions from the study of behavior? In answering this question we may as well proceed chronologically as otherwise, and as frequently heretofore we shall permit observers to speak for themselves.

> It made use of its sense of smelling in order to decide upon the nature of the aliments which were presented to it and which it was not acquainted with, and it seemed to consult this sense with great assiduity.

For quoting this matter-of-fact statement and unescapable information of F. Cuvier (1811, p. 190) we have numerous and excellent precedents.

A few years later Grant confirmed the observation of Cuvier and thus added an iota to his description:

> He evidently possesses an insatiable fund of curiosity, and examines every thing that comes in his way. No matter what the article may be, he turns it about in his fingers, smells it, and tries if it is eatable. In examining any thing he is seldom or never satisfied with the sense of manual touch. (Grant, 1828, p. 8.)

Touch, taste, and smell are thus envisaged!

Follows Warwick with comparable remarks on responsiveness to sounds:

> The hearing of both animals [an orang-outan and a chimpanzee] was remarkably acute, catching the most indistinct noise at a considerable distance; and their knowledge of sounds was accurately shown; as, on hearing the footsteps, on the stairs, of persons with whom they were acquainted, they ran towards the door before it was opened. (Warwick, 1832, p. 308.)

Schlegel and Müller undoubtedly had excellent and abundant opportunity to observe receptive behavior and modes of sense in the orang-outan, but, notwithstanding, their reports carry little new information. Better than in their own publications their principal results are presented by Temminck.

> The sense organs of the orang do not seem to be very acute, with the single exception of hearing which is extraordinarily fine. Though its eyes, of a clear brown, are full of vivacity and are very expressive, it seems to have rather low vision. When in captivity one of them is shown cultivated fruit, his desire to possess it is extreme; as soon as he gets hold of it, he regards it closely, touches it, smells it, then rejects it with indifference. Whatever falls into his hand is immediately carried to within a short distance of his eyes, and secondly straight to his nostrils, which makes one suspect that this sense is slightly less developed than sight. In the modality of touch little acuteness can be attributed to him; he has less in his fingers than other species of quadrumanous animals; with him the lips seem to replace their principal functions, especially the lower lip which he has the ability to extend in the shape of a vase and to lengthen to test the objects which he has picked up. (Temminck, 1835-41, pp. 378-379.)

Reference is made by Schmidt (1878, p. 227) to sensitiveness of the skin of the young orang-outan to slight irregularities in the surface on which it sits or lies, and also to "love" of bright colors, with seeming preference for red over white. Amateurish experimental tests of sensitiveness to various wave lengths of light are reported by Garner (1892a) and Furness (1916), but since their investigations belong rather under perception than sensitivity, further exposition will be deferred.

Our survey of human knowledge of receptivity in the orang-outan, the accumulation of centuries, is completed. The result may be expressed in a sentence. Modes of sense or receptivity have not been listed

and there are no data on range, acuity, thresholds, or any other psychobiological aspect of any sense.

It is either to laugh or weep if one contemplates this display of ignorance or of inaptitude and unpreparedness for skilful inquiry. Even as we present these exhibits we choose to laugh, for the situation strikes us as incredibly absurd. Nevertheless, instead of holding up to ridicule pioneers in anthropoid research we naturally should prefer to say simply and solely, "Nothing worthy of mention in a scientific publication is known about receptivity and sensibility in the orang-outan." This, moreover, is the fact we should like to leave vividly in the mind of every inquiring psychobiologist.

CHAPTER FIFTEEN

INTELLIGENCE OF ORANG-OUTAN: PERCEPTION, ENDOWMENT, AND ACQUISITION

THIS section might appropriately be entitled "Intelligence in behavior and experience," for the term intelligence in comparative psychology has come to imply varieties of experience and activity which present adaptive relations. Using the conventional terminology of our science, we shall examine behavioral evidences of perceptual, imaginal, and ideational processes. For those who disclaim interest in experience, or who attempt to exclude it from the realm of scientific inquiry, there remains description of behavior which is not a whit altered by being characterized by us as perceptual, imaginal, or ideational.

Logically viewed, thorough knowledge of an organism's receptive characteristics should constitute the basis for examination of perceptual modes of integration of activity and experience. Given such a basis, it is doubtful whether better approach to understanding of behavioral adaptation, of any order of complexity of integration, can be commanded than the analytic and genetic study of perceptual and apperceptual (configurational and coördinative) processes.

As we have searched the literature for information about receptivity in the orang-outan, so likewise have we sought data on perception. And in this case as in the other, in place of a consistent and serviceable body of fact, we have found fragmentary observations, bits of evidence unrelated and impossible of evaluation; nothing more. We may not present the motley array of data, but we shall offer typical examples.

Perception of temporal sequences, relations, and span, although doubtless noticed by many observers, are recorded by few. Warwick (1832, p. 309) remarks:

> It would seem that they had some knowledge of time; for, as the hour approached at which they were removed to their nightly residence, they would of their own accord get the blankets, and enfold themselves, in readiness to depart; and if their removal were protracted beyond the usual time, it required force to prevent them from going to the door.

Similarly in our own acquaintance with the orang-outan, we have noticed awareness of the approach of hour for feeding, experimentation, or retirement. No experimental work has been done, and it is, therefore, impossible to present measurement or precise description of perceptual processes and of the external and internal factors which presumably condition them. It seems not unlikely that this type of adaptation plays an important part in the life of the animal.

Perception of mirror images of the self, of other objects, and of moving things, have many times been reported, although never carefully studied and adequately described. Such data as are available afford no indication of the nature and limitation of perception of size, form, distance, movement, light, and color. The mirror situation appears, however, to offer admirable opportunity for experimental analysis of certain aspects of visual perception. All that seems definitely established by such casual observations as are recorded is the fact of recognition of certain mirrored objects and ability to respond appropriately.

Perhaps the best indication of perceptual processes is contained in the investigative or observational activity of the orang-outan. Systematic examination of cages and of unfamiliar objects is commonly observed; and Schmidt, for one, has given a very illuminating account of the exploratory activities of one of his subjects, and especially of its minute and intensive examination of a new

cage and of a chair which was present as plaything. Particularly worthy of note is this writer's description of the animal's perception of depth as indicated by its reaction to paintings on the ceiling. These were felt of with the fingers as if with expectancy of tridimensionality (Schmidt, 1878, p. 267).

The attempts of Garner and Furness to study size, form, and color perception in the orang-outan yielded no definite information. Neither of these men was professionally equipped for his task. Each took his cue from "intelligence testing." As object lesson, and in order to render our destructive criticism intelligible, we present description of method and results in the words of these authors.

Working with an orang-outan, estimated to be five years old, in London, Garner proceeded in accordance with the following description and with the result indicated:

I took two small paper boxes about five inches square by one inch deep and lined them with pieces of cigar box in order to make them as strong as possible. I covered one box with bright green paper and in the lid cut a round hole about two inches in diameter. I then cut out a disc about the size of this hole to which I attached a knob to facilitate handling it, and this disc I also covered with green paper. The other box I covered with yellow and through the lid of it cut a square hole also about two inches across. For this I made a square block or plug with knob, and covered it with yellow paper. My object was to see if the ape would put the blocks into the holes which they fitted, and also to ascertain if he was guided by the shape of the hole and block or by the colour.

I entered the cage with my boxes. . . . I first took the round block in my fingers and showed it to him and then fitted it into the hole in the box-lid. The ape immediately wanted it, and when I let him have it he tried to put it into his mouth. I showed him a number of times what I wanted him to do, and after a little time I got him to drop the plug on the box and at last to put it into the hole; and when he did this I promptly rewarded him with a bit of apple which I had taken into the cage for this purpose. The second time it was an easier matter to induce him to put the plug into the hole and it seemed to dawn upon his mind that he was getting paid for his trouble, and he performed it more readily and after each effort would look up for his apple. I did but use one box on this first trial and did not continue the experiment long enough to tax his patience, but whenever he put the plug on the box or in the hole I would give him his reward, and this part of the programme seemed to be more easily understood.

A few days later I visited him again, and on this occasion I took both boxes into the cage and placed them before him and at the same time gave him the green plug to place. He at once dropped this into the right box and looked up for his apple. This was done so promptly that I could not doubt but that he was aware of what he was doing. I then gave him the square plug, which he first attempted to put into his mouth and then finally dropped it into the wrong hole; each time he dropped the green plug into the right box, but the yellow one he usually got wrong. At last, when I would not allow him to put the blocks into his mouth nor into the same hole, he declined to play the game and would not take hold of either one except to throw it down into the straw and turn away. . . . When I gave him the block he would try to put it into his mouth, and when not allowed to do this would drop it and turn away. . . .

On another visit to Jim . . . I gave him a bite of apple to start with and then I placed in his hand the square plug, which he immediately placed in the square hole. This was rewarded with a bit of apple. I then gave him the round block, which he proceeded to deposit in the square hole. After some little debate he placed it in the right hole, and I then gave him the square block, which he placed in the same hole. After a great many efforts I discovered one singular fact. No matter which block I gave him he would generally fit it into the hole of the same shape, but seemed determined always to place the second block in the same hole. I was satisfied from my experiments that he could easily distinguish the round hole from the square, and he knew evidently which block fitted it, but what reason he had for wanting to put both blocks in the same hole was not clear to me. In a few cases where I compelled him to put the second block in the right hole he endeavoured to recover the first block which he had deposited in order to place it in the same hole, and when I gave it to him he would immediately do so. He seemed quite determined not to separate the blocks. (Garner, 1892a, pp. 440-442.)

Because of lack of critical analysis of visual factors in this experimental situation and their independent evaluation, this work proves nothing beyond the fact of perceptual process.

In commenting on the behavior of an orang-outan and a chimpanzee which he observed, Furness says, "Both of them have been taught to know red, blue and yellow

by name and the chimpanzee can select and place in separate piles blocks colored violet, blue, green, yellow, orange and red." There follows this author's description of his tests of color vision and their outcome.

In testing their color sense I tried first with a red, a blue and a yellow block and a board whereon were painted squares of the same colors a little larger than the blocks; I showed them over and over again what I wanted them to do and saying the names of the colors as I placed the blocks on the squares correspondingly colored. Then a block was given to them and they were expected to place it correctly, but it never was done in a way to convince me that they recognized the color. Next they were tested with pieces of ribbon of exactly the same length and width and luster; I endeavored to get them to select and hand to me the color that I asked for. For a month or more I thought that they knew the colors, but to make sure I placed the ribbons in another room and told one of the apes to go and bring me one of the colors, and while she was getting it I kept repeating the name of the color so that she should not forget. This was a complete failure, again and again. They evidently had been reading my expression and the direction of my eyes, when, sitting opposite to them, unconsciously, I followed the direction of their hesitating hands with a glance of approval or disapproval. This was really very observant on their part, but not to the point. They were completely at a loss when I closed my eyes and held out my hand to receive the color that I had asked for.

This did not prove, however, that they could not recognize the different colors; merely that they did not know them by name. The next trial therefore was with 24 blocks, 8 red, 8 blue, 8 yellow; all scattered over the table. One color was called for by name and if that was selected rightly then all the others of that color must be picked out and placed in my hand. I would never accept a wrong color, but would either close my hand or snap it out of their fingers; the lesson would not stop until all the eight blocks of each color had been rightly selected, so they gradually learned that a quick selection of right colors meant a speedy release to play. In this manner also they learned the names of the colors as applied to blocks, but if other red, blue and yellow objects such as ribbons were placed among the blocks I could never get the apes to consider them in the same category as the blocks merely because they were of the same color. (Furness, 1916, pp. 287-288.)

Certain indications of form discrimination by the orang-outan and chimpanzee also are given by Furness, who remarks that these animals knew the correct key for every lock in their apartment and could select the proper one from a bunch of ten or twelve. When tested with duplicate keys on different rings the right keys were always selected. Of the keys involved two were for Yale locks and difficult to distinguish (Furness, 1916, pp. 285-286).

The publications of Garner and Furness remind us that amateur work has its place and value, but that it should be clearly recognized and distinguished from professional inquiry. Psychobiology has reached the stage of development when its makers should insist on professional competency and on the critical evaluation of work.

Incidental to an experimental study of aspects of intelligence in the orang-outan, Haggerty observed certain evidences of perceptual process.

There is [as he puts it] behavior which depends upon the animals grasping the objects, not in the accidental way in which they may happen to come to it, but in the relation in which they will be most useful to it. If we are to speak anthropomorphically, we must say that the animal perceives relations, and that in this perception of relations we have a low order of rationality. (Haggerty, 1913, p. 154.)

Likewise in our own general and experimental studies of the orang-outan, various indications of perceptual process have incidentally been noted, although never fully described (Yerkes, 1916). Many of the experimental situations to be described later, and the adaptive responses of the orang-outan to them, clearly enough indicate the functional presence of sensory and imaginal configurations. They are in part kinaesthetic, in part tactual, and in part visual. Of auditory perception, or that which involves chemical or orientational receptivity, we have no definite knowledge.

Not without interest, in this connection, is an observation which we take from Shelford:

The young Maias when it picks up a very small object, such as a pea or pellet of bread, does so, not with the tips of the thumb and first finger, but pushes the object with the ball of the thumb against the side of the proximal phalanx of the

first finger, all the fingers being flexed, and, so holding it, lifts it up. A young baby nearly always acts in the same way when trying to pick up a small object. (Shelford, 1916, p. 5.)

This suggests the desirability of minute study of the processes of exploration and investigation of objects by which the orang-outan familiarizes itself with their properties and achieves motor coördination and adaptation. There are many fragmentary observations bearing on this topic, but no one has assembled them in such way as to indicate their relation, and there is no systematic experimental study of any single aspect of motor adaptation and coördination.

Bearing rather on perception than on visual acuity is the following observation reported by Sheak:

One afternoon when I was standing in front of his cage, he left his place in the farther corner, came over to the front, and, stretching his arm through the bars, put his hand on my shoulder. At first I could not imagine what was engaging his attention, but when he took his hand away I discovered there was a tiny knot in the thread of the seam of my coat, and he was trying to get it. I had not noticed it before, but his sharp eyes had seen it from the back of the cage. (Sheak, 1923, p. 48.)

What, then, do we know of the perceptual life of the orang-outan? Nothing, of any considerable consequence for scientific description. There has been no well-planned systematic study of the subject, nor indeed of any aspect of it. This is the more surprising since knowledge of integrative processes, at the perceptual level, is a primary condition of fruitful study of imaginal and ideational adaptation. Therefore, we venture to predict that the problems of receptivity and of perceptual integration will shortly command the attention of psychobiologists who may interest themselves in the orang-outan.

INSTINCT AND ACQUISITION

The suspicion is prevalent that adaptive behavioral processes are of two sorts: primary acts or fundaments which are relatively independent of individual experience, and their supplements or modifications. Like heredity and environment in the life of the organism, they are inseparable and perhaps also inextricable by present methods of analysis. Indeed, their interdependence is the most conspicuous aspect of relationship. In this chapter on orang-outan adaptivity it is appropriate to recall that by various authorities certain ideas as well as certain acts have been considered innate. We choose F. Cuvier as spokesman of the group because of his intimate acquaintance with a baby orang-outan.

It appears to me, that some authors have made intelligence depend much more than was just on the greater or less perfection of the hands or fingers. Now although the hand of an ape and of an ourang outang differs very little from ours, and these animals could undoubtedly make the same use of them as we do, if they were actuated by the same ideas, yet an ourang outang would no more be a man with more perfect hands or fingers, than a man would be an ape because he was born without arms. The influence of the senses on the mind has been particularly exaggerated: some authors have thought that upon the degree of perfection of these organs the degree of the perfection of the understanding in a great measure depended. Nevertheless it must be admitted that several animals have senses completely similar to ours; and the description which we have given of the ourang outang shows that this animal, which certainly is not a man, has received senses equally numerous, and at least equally delicate with ours. Besides, if we consider the real influence exercised on the operations of the understanding by more or less delicate organs, we see that it is limited to the multiplying of ideas in a greater or less ratio, without making any change in the manner of setting these elements at work. The most humble artisan, who has exercised his sight least, and who cannot distinguish the most striking shades of colour, will not be less of the same species with the painter who has studied all the accidents of light, and who can recognise them in the slightest undulations of a drapery. Lastly, the understanding may have ideas without the aid of the senses: two thirds of the brute creation are moved by ideas which they do not owe to their sensations, but which flow immediately from their brain. Instinct constitutes this order of phænomena; it is composed of ideas truly innate, in which the senses have never had the smallest share. Every thing unites, therefore, in my opinion, to convince us that it is neither in the conformation of the limbs, nor in the greater or less perfection of the senses, that we must seek the principal cause of the intellectual qualities which distinguish us from the lower animals, and even the cause of those

which perhaps distinguish the animals of certain classes. The operations, the phænomena of our intelligence which characterize us, ought to proceed from higher and more potent causes; faculties, even of the understanding, or of the organ in which these faculties reside, *i.e.* the brain. Consequently, we apply ourselves much more to appreciate the use which our ourang outang made of its sensations, the results which he knew how to draw from its ideas, than to analyse these sensations themselves, or to seek for the elements and the nature of these ideas. (F. Cuvier, 1811, pp. 192-193.)

Today we question the correctness of Cuvier's views as to the innateness of ideas and acts, and many competent observers feel reasonably sure that, in the main, action patterns and systems are products of individual practice and experience. It is commonly assumed now that from certain simple acts or assemblages of acts by accretion, elaboration, integration, coördination, inhibition, facilitation, and yet other types of modification, develop complex adaptive behavioral expressions and responses.

In orang-outan nest building, walking, climbing, feeding, flight, fighting, vocalization, play, sex and parental behavior, what is primary or hereditary and what acquired through individual experience? In no instance can answer be made, for observational data are lacking.

Although it is illogical and relatively unprofitable to have to consider behavioral adaptations in the absence of dependable information about the fundaments of activity, as also about essential characteristics of receptivity and perception, we may not escape our present task of review. We purpose, therefore, to offer the substance of knowledge about conditions, modes, and characteristics of behavioral adaptations, and other aspects of "intelligence" in the orang-outan.

IMITATION

There are, it appears, in this great ape as well as in other primates, certain basically important conditions, or are they also modes, of adaptation. Often they are spoken of as behavioral tendencies or traits, and to them are applied such terms as fooling, aping, imitating, investigating, examining, trying, experimenting, destructiveness, curiosity. Elsewhere we have defined the strategic terms in this assemblage.

Fooling, in the sense of working with objects in a seemingly purposeless but exploratory fashion, is characteristic of certain types of mammal, and especially of the primates; characteristic also of certain periods of development, as for example human infancy and the early stages of many of the infrahuman primates. Presumably the more readily and persistently an animal fools with the objects of its environment, the more rapidly it learns their qualities and comes to adjust itself profitably to them. From one point of view what I term fooling or monkeying is the initial or primitive form of research!

In aping, as contrasted with fooling, the influence of social suggestion or copy becomes dominant and determining. The act or assemblage of acts may be no more purposeful, or indeed profitable, than those of fooling, but they at least tend to reproduce more or less precisely the reaction of another organism or some other type of object, and are direct and immediate responses to those external events. In us yawning, coughing, sneezing, smiling, frequently occur in response to similar acts of other organisms and are in the sense of this paragraph instances of aping.

I have reserved the term imitating for acts the stimulus of which is supplied by the activity of another organism and the form of which is determined primarily by the objective obviously attained by the other organism. There are, to be sure, many usages of the term imitation, and it is undeniable that imitative tendency in organisms expresses itself in varied forms of activity and with varying degrees of consciousness of end and of means as leading to that end. (Yerkes, 1927, p. 152.)

As nearly as we can determine from the literature, and from our own observations, fooling is less conspicuous in the orang-outan than in many monkeys. This may be because it is more definitely controlled and precisely directed; more systematic and hence more highly observational, investigative, and experimental. Almost all of the naturalistic descriptions of the behavior of captive orang-outans refer more or less explicitly to this phase or aspect of activity and indicate either its perceptual or its adaptive significance and relations.

Curiosity manifests itself in the orang-outan as in all other primates, but basis for

comparative statement is lacking. We suspect from meager evidences that it is greater than in the gibbon and gorilla, but distinctly less perhaps than in the chimpanzee. Typical of such mentions of the phenomenon as are common in the literature are Grant's reference to lively curiosity about persons, unfamiliar objects, and unusual events (Grant, 1828, p. 7); the account by St. John "that whenever a bullet glanced on a tree or branch near him" an orang-outan which was being hunted "put out his hand to feel what had struck the bark" (St. John, 1862, p. 23); and Schmidt's remarks about persistent curiosity directed toward a thermometer (Schmidt, 1878, p. 269). Such statements suffice only to establish the fact. There are no precise or detailed descriptions of curiosity-signifying behavior, no measurements thereof, and no indications of its relationship to age, sex, type, individuality, or experience.

With aping and the various forms and degrees of imitative tendency through which it gains expression, the situation is different, for there is more ample information. It is in fact sufficient to establish definitely the tendency as an essential feature in orang-outan adaptation and to convince us that without careful study of its imitative aspect, our understanding of the intelligence of the orang-outan will remain imperfect. So numerous are the casually remarked instances of what is assumed to be imitative activity that we may not do more than offer a few typical examples and present certain general statements which we believe to be justified by the present status of knowledge.

Spitting by an orang-outan in imitation of man is briefly described by Vosmaer (1778, p. 18). Flourens recounts the attempts of a young specimen to imitate the posture, motions, and use of a cane as observed by it in the hands of an old man (Flourens, 1845, p. 44). In his attempts to train orang-outans to habits of visual discrimination and to imitate human sounds, Furness (1916) observed varied expressions of imitative tendency, although imitations of sounds were difficult to elicit. As approached experimentally by Haggerty (1910, 1913), Yerkes (1916), and Shepherd (1923), the subject has afforded negative as well as positive results. Under certain circumstances, as might naturally be expected, aping and other forms of imitation may be very pronounced, whereas under somewhat different conditions they may fail to appear.

To sum up, and also formulate conclusions, we would submit that captive orang-outans, especially when young, have frequently been observed to imitate one another and also such human activities as the use of objects for varied purposes. It appears that tendency to reinstate visual, cutaneous, and kinaesthetic stimuli is much stronger as judged by frequency of observation than in the case of auditory stimuli, or, in other words, that the animals more readily imitate what is seen than what is heard. It is established that definitely purposive imitation plays a highly important rôle in the adaptive life of this ape.

DEGREE OF INTELLIGENCE

Impressions, opinions, inferences, and conclusions about the "intelligence" of the orang-outan, with few exceptions, agree in ranking it above other mammals and on the mental plane of the other anthropoid apes. Despite their relatively unscientific quality, we shall offer typical examples of these observations and pronouncements, for they are not without value, although neither are they the sort of stuff from which the lasting fabric of knowledge is woven.

Vosmaer's subject one day, after observing him open a lock with a key, took up a bit of wood and thrusting it into the keyhole, turned it in all directions, and thereupon looked to see if the lock had opened. The same individual, when held in her cage by a stout chain, discovered a large nail which she proceeded to use as a lever (Vosmaer, 1778, p. 17). The imitative use of both key and lever has been many times observed in the orang-outan and several times reported. Always it impresses the observer as "remarkable."

To judge by the following quotation, F. Cuvier was even more strongly convinced than Vosmaer of the high order of intelligence possessed by the orang-outan.

This desire for marks of kindness generally led our ourang outang to search for persons whom it knew, and to shun solitude, which seemed to displease it so much that one day it employed its intelligence in a singular way to break loose from it. It was shut into a closet adjoining the room where the people of the house usually met: several times it ascended a chair in order to open the door, which it effected, as the chair usually stood near the door, which was fastened with a latch. In order to prevent it from repeating this operation, the chair was removed some distance from the door; but scarcely was it shut when it again opened, and the ourang outang was seen descending from the chair, which it had pushed towards the door in order to enable it to reach the latch. Can we refuse to ascribe this action to the faculty of generalizing? It is certain that the animal had never been taught to make use of a chair for opening doors, and it had never even seen any person do so. All that it could learn from its own experience was, that by mounting upon a chair it could raise itself to a level with things that were higher than it; and it may have seen from the actions of others that chairs might be moved from one place to another, and that the door in question was moved by lifting the latch: but these very ideas are generalizations, and it is only by combining them with each other that the animal could have been led to the action which we have related. I do not think that any other animal ever carried the force of reasoning further. (F. Cuvier, 1811, p. 197.)

And in the following description, Abel offers materials which he evidently considered indicative of unusual "sagacity."

In his attempts to obtain food, he afforded us many opportunities of judging of his sagacity and disposition. He was always very impatient to seize it when held out to him, and became passionate when it was not soon given up; and would chase a person all over the ship to obtain it. I seldom came on deck without sweetmeats or fruit in my pocket, and could never escape his vigilant eye. Sometimes I endeavoured to evade him by ascending to the mast-head, but was always overtaken or intercepted in my progress. When he came up with me on the shrouds, he would secure himself by one foot to the rattling, and confine my legs with the other, and one of his hands, whilst he rifled my pockets. If he found it impossible to overtake me, he would climb to a considerable height on the loose rigging, and then drop suddenly upon me. Or if, perceiving his intention, I attempted to descend, he would slide down a rope and meet me at the bottom of the shrouds. Sometimes I fastened an orange to the end of a rope, and lowered it to the deck from the mast-head; and as soon as he attempted to seize it, drew it rapidly up. After being several times foiled in endeavouring to obtain it by direct means, he altered his plan. Appearing to care little about it, he would remove to some distance, and ascend the rigging very leisurely for some time, and then by a sudden spring catch the rope which held it. If defeated again by my suddenly jerking the rope, he would at first seem quite in despair, relinquish his effort, and rush about the rigging, screaming violently. But he would always return, and again seizing the rope, disregard the jerk, and allow it to run through his hand till within reach of the orange; but if again foiled, would come to my side, and taking me by the arm, confine it whilst he hauled the orange up. (Abel, 1818, p. 326.)

To an anonymous writer must be credited description of certain behavior in a captive orang-outan

whose intelligence is developed to a remarkable degree and who daily gives proof of an excellent disposition. . . .

He seems to understand what is said to him and obeys orders. Recently in the presence of Prof. Geoffroy Saint-Hilaire and a friend he performed as follows: He was accustomed to have his chief meal at five o'clock; this he knew exactly, and as soon as the hour struck would clamber onto a rope hanging down from the ceiling of his room, set it in motion and swing himself over to the lock of the door leading to the eating room. He would rattle the door until it was opened. On this day the keeper had put three knots in the rope making it too short to reach the door. When the orang discovered this he untied one of the knots and tried to see if it would reach the door. Since it would not he untied the second. Again failure. The third knot was almost at the upper end of the rope. The orang climbed down without attempting to untie it since his efforts would only make it tighter. He climbed up above the rope and then managed it with the same ease as the others, reached the door which was opened for him, and went to the table. In this behavior there was more than mere skill; he showed a gift of observation and the ability to reason. (Anonymous, 1836, p. 153.)

Intent on the daily life of the orang-outan, Schlegel and Müller have little to say about matters psychobiological. A sentence covers their estimate of intelligence.

In all his manners and actions he showed indisputably a very high degree of intelligence, al-

though, as G. Cuvier rightly remarks, it recently has been too highly estimated and too much exaggerated, yet so also is the contention that in this regard the orang-outan does not excel the dog. (Schlegel and Müller, 1839-44, p. 21.)

The statement of G. Cuvier to which reference is made reads as follows in an English translation which we have at hand.

When young, and such as he appears to us in his captivity, he is a mild and gentle animal, easily rendered tame and affectionate, which is enabled by his conformation to imitate many of our actions, but whose intelligence does not appear to be as great as is reported, not much surpassing even that of the Dog. (G. Cuvier, 1831, p. 58.)

In the works of Rennie (1838) and Martin (1841), to which reference has been made repeatedly, will be found additional observations and deductions relative to orang-outan intelligence and similar to those which we have quoted. Inasmuch as we are presenting samples instead of a complete exhibit of evidences and shall later offer summary statements and generalizations, we shall not reproduce any of the excellently presented but secondhand materials of these really admirable natural histories.

Few observers have contributed more in brief compass and from general observation to knowledge of the psychobiological characteristics of the orang-outan than Schmidt. His descriptions of play, receptivity, emotional expressions, observation, behavior toward mirror images, the examination and testing of objects, the use of tools, the apparent understanding of symbols, all contribute significantly to knowledge of the animal's intelligence. Evidently this observer was strongly impressed by the persistence and resourcefulness of his subject in achieving objectives, and in this connection he cites several instances and incidents (Schmidt, 1878).

Report of the use of objects as tools or instruments is made by Reuvens (1889, pp. 184-185), who as proof of intelligence in a healthy, active captive which for over three years had lived in confinement, tells how, desiring to reach an orange outside its cage, it tried to work a piece of sacking used as bed cover through the cage netting in several places at once. Unsuccessful in this "after long reflection it discovered that the sacking must be pushed between two bars of the cage; it did this and succeeded in throwing it over the orange, pulled it in and threw again repeatedly, until the delicacy could be reached." When another orange was placed somewhat farther away so that the sacking was too short to reach it, the animal, according to report, long thought over the matter before it achieved a new method. Finally, it threw the first cover over the orange, then a second cover over the first, and pulled both covers and orange to it. Needless to say, observations such as this have little scientific value apart from definite knowledge of the history and circumstances of the behavior.

Diverging from what seems to be the consensus of opinion with respect to the intelligence of the orang-outan is the expression of Garner, who with what appears to us entirely inadequate knowledge of the facts then available says, "He is the most obtuse or stupid of the four great apes." (Garner, 1896, p. 260.) And further, by way of comparison of the anthropoids: "If placed in the order of their mental and social characteristics they stand as follows: the chimpanzee, which is next to man, the gorilla, the gibbon, and, last, the orang. It is possible, however, that it may yet be found that the gibbon is intellectually the highest of this group." (Garner, 1900, p. 4.) The erroneousness of Garner's statements is almost as certain as their divergence from the commonly held opinion.

The excellent observational opportunities of Sokolowsky yielded him certain facts upon which he bases such psychobiological statements as these:

In these psychological observations of the distinctive behavior, the chimpanzee and orang especially interested me. Through a deeper and finer insight into the emotions of these apes I was led to believe in a division of their mental activities, if I might so express it, in different directions. Although the orang as well as the chimpanzee is a very intelligent animal, yet the external expres-

sions of their activities show important differences from one another. (1908, p. 15.)

The orang has been considered less gifted in comparison with the chimpanzee. I cannot corroborate this. The orang does not possess in the same degree the extraordinary liveliness or, in my own opinion, the great mental gifts of the chimpanzee; nor, I might say, the flight of thought of the latter, but he appears in his whole mental make-up to have a much greater perseverance. The difference in mental ability in these two animals, as I can observe daily, is such an enormous one that it would be impossible to underestimate, to overlook, or to deny it. (P. 65.)

There occur throughout the writings of Hornaday descriptions of, and references to, intelligent behavior in the orang-outan. He has gathered the fruits of his long and extraordinarily varied experience with this great ape in a chapter on "The mental status of the orang-outan" (Hornaday, 1922). From this chapter we quote selectively.

For several reasons, the great apes, and particularly the chimpanzees and orang-utans, are the most interesting subjects for psychologic study of all the wild-animal species with which the writer is acquainted. Primarily this is due to the fact that intellectually and temperamentally, as well as anatomically, these animals stand very near to man himself, and closely resemble him. The great apes mentioned can give visible expression to a wide range of thoughts and emotions. (P. 71.)

Despite the difference in temperament and quickness in delivery, I regard the measure of the orang-utan's mental capacity as being equal to that of the chimpanzee; but the latter is, and always will remain, the more alert and showy animal. The superior feet [foot] of the chimpanzee in bipedal work is for that species a great advantage, and the longer toes of the orang are a handicap. Although the orang's sanguine temperament is far more comforting to a trainer than the harum-scarum nervous vivacity of the chimpanzee, the value of the former is overbalanced, on the stage, by the superior acting of the chimp. For these reasons the trainers generally choose the chimp for stage education. (P. 72.)

The orang is distinctly an animal of more serene temper and more philosophic mind than the chimpanzee. This has led some authors erroneously to pronounce the orang an animal of morose and sluggish disposition, and mentally inferior to the chimpanzee. After a close personal acquaintance with about forty captive orangs of various sizes, I am convinced that the facts do not warrant that conclusion. The orang-utans of the New York Zoological Park certainly have been as cheerful in disposition, as fond of exercise and as fertile in droll performances as our chimpanzees. Even though the mind of the chimpanzee does act more quickly than that of its rival, and even though its movements are usually more rapid and more precise, the mind of the orang carries that animal precisely as far. . . . (P. 73.)

Without any great amount of labor, and with no real difficulty, our orangs were trained to perform the following simple acts:

1. To sit at table, and eat and drink like humans. This involved eating sliced bananas with a fork, pouring out milk from a teapot into a teacup, drinking out of a teacup, drinking out of a beer bottle, using a toothpick, striking a match, lighting a cigarette, smoking and spitting like a man.
2. To ride a tricycle, or bicycle.
3. To put on a pair of trousers, adjust the suspenders, put on a sweater or coat, and a cap, reversing the whole operation after the performance.
4. To drive nails with a hammer.
5. Use a key to lock and unlock a padlock. The animal most proficient in this became able to select the right Yale key out of a bunch of half a dozen or more, with as much quickness and precision as the average man displays.

The orang Dohong learned to pedal and to guide a tricycle in about three lessons. He caught the two ideas almost instantly, and soon brought his muscles under control sufficiently to ride successfully, even under difficult conditions.

It was quickly recognized that our Rajah was a particularly good subject, and with him the keepers went farther than with the four others. From the first moment, the training operations were to him both interesting and agreeable. The animal enjoyed the work, and he entered into it so heartily that in two weeks he was ready to dine in public, somewhat after the manner of human beings. (P. 75.)

Descriptive of an orang-outan who was more nearly a mechanical genius than an actor, Hornaday writes:

Dohong was of a reflective turn of mind, and never was entirely willing to learn the things that his keepers sought to teach him. To him, dining at a table was tiresomely dull, and the donning of fashionable clothing was a frivolous pastime. On the other hand, the interior of his cage, and his gymnastic appliances of ropes, trapeze and horizontal bars, all interested him greatly. Every square inch of surface, and every piece of material in his apartment, was carefully investigated, many times over.

. . . .

Dohong's use of his lever was seen by hundreds of visitors and one frequent visitor to the Park, Mr. L. A. Camacho, an engineer, was so much

impressed that he published in the *Scientific American* an illustrated account of what he saw.

For a long period, Dohong had been more or less annoyed by the fact that he could not get his head out between the front bars of his cage, and look around the partition into the home of his next-door neighbor. Very soon after he discovered the use of the lever, he swung his trapeze bar out to the upper corner of his cage, thrust the end of it out between the first bar and the steel column of the partition, and very deftly bent two of the iron bars outward far enough so that he could easily thrust his head outside and have his coveted look.

One of our later and largest orangs made a specialty of twisting the straw of his bedding into a rope six or seven feet long, then throwing it over his trapeze bar and swinging by it, forward and back.

Time and space will not permit the enumeration of the various things done by that ape of mechanical mind with his swinging rope and his trapeze, with ropes of straw *twisted by himself*, with keys, locks, hammer, nails and boxes. Any man who can witness such manifestations as those described above, and deny the existence in the animal of an ability to reason from cause to effect, must be prepared to deny the evidence of his own senses. (Pp. 77-80.)

Covering a period of more than one and one-half centuries, we have sampled information about the mentality of the orang-outan as well as inferences and beliefs concerning it. Although the list of contributors to this subject might be very greatly extended we cannot convince ourselves that any advantage would be gained by doing so. We shall instead conclude this chapter on aspects of behavioral adaptivity with the statement that we have endeavored to select typical examples of the various types of observation and reflection and also to exhibit the methods, points of view, and conclusions of observers with such diverse training and interest as hunter and anatomist, collector and taxonomist, naturalist and historian.

CHAPTER SIXTEEN

INTELLIGENCE OF ORANG-OUTAN: EXPERIMENTAL STUDIES

IN the remote period of human acquaintance with the orang-outan, speculation and imaginative constructions overshadowed observation. Subsequently naturalistic interest and unchecked or uncontrolled observation of both free and captive specimens of the ape largely supplemented speculation. In the present century experimental inquiry as a means of furthering acquaintance with orang-outan behavior, and of solving psychobiological problems presented by it, has become dominant.

As was true of the gibbon, so also of the orang-outan; there are few experimental studies to consider. The first, chronologically, is that of Haggerty, who in 1913 published in a popular magazine a brief account of certain experiments on two orang-outans in the New York Zoölogical Park. The work has been overlooked or neglected by students of behavior because of the nature and place of publication. We propose here to quote it at length because it is the first study of its kind made with orang-outans, reliable in method and observation, important in its results, and virtually unknown to those who should be most familiar with it.

Whether animals do or do not reason will probably remain a mooted question for some time to come. Certain it is that the case can not be closed until we have experimental evidence from the anthropoid apes; and although these animals stand nearest to man in point of structure, we know next to nothing of their intelligence. It is the purpose of this paper to add something to the experimental data, and to interpret the data in the light of current theories of animal intelligence.

For fully fifteen years the "sense-impulse" theory of animal learning has held sway. The essence of this theory is that *an animal can learn to do a thing only by doing it.* Owing to its inherited characters, an animal makes many movements, and, except in the case of the exact instincts, the movements are more or less random. These movements are accompanied by feelings of innervation, impulse feelings. If *by chance* one such random movement brings about a pleasurable result, the impulse feeling becomes associated with the pleasure of the result, and both of these with the stimulus that first called forth the reaction. By this complex association of sense, impulse, and pleasurable feeling, the act tends to be confirmed and to be molded into a habit.

My attention was turned toward the apes while I was making an investigation of other species of primates at the New York Zoölogical Park. The weird humanness of the orang-utans and chimpanzees attracts great crowds to their cages, and I soon found myself daily among the crowds, trying to decipher the mental qualities of these strangely clever animals. It grew upon me that the orthodox sense-impulse theory was not a sufficient explanation of what I witnessed, and, in order to test the matter, I had some simple apparatus constructed.

Betty and Nancy, the subjects of my investigation, were two vigorous female orangs about four years old [doubtless an underestimate], and weighing about a hundred pounds apiece. They were very strong, docile, affectionate, playful, and of good disposition.

The behavior of the orangs always had the air of deliberation. There would often be a long series of acts, all tending toward a single final act, which might not be apparent to the observer at first, but toward which the animals worked, as if with conscious intention of the final result.

. . . .

In my experiments, the animals were given the problem of getting food. Two devices were used. The first, which I shall call the table experiment, was arranged in the following manner. The bars along the front of the animals' cage were upright and about five centimeters apart. On the outside of this cage, and on a level with the floor of it, was adjusted a table seventy-five by forty-five centimeters. One end fitted close up to the bars and the table projected out from the cage. Around the edge of the table was an upright strip three centimeters high.

Food (bananas and grapes) was placed on this table, beyond the reach of the animal's hand. Inside the cage was a stick seventy-five centimeters in length. One end was large enough for the animal to grasp easily; the other end tapered to a point, to which was fastened a wire hook. The large end of the stick was attached by a long chain to the outside of the cage-frame. The stick was then put into the cage, between two bars at

one side of the table, and was laid, with the hook end outward, immediately at the edge of the table.

The second device I shall designate the pipe experiment. A hollow iron pipe, five centimeters in diameter and sixty centimeters long, was fastened in a horizontal position to the bars of the cage, about seventy centimeters from the floor of the cage. Food was placed in the pipe beyond the distance the animal could reach with his hand. A stick, seventy centimeters long and large enough to be grasped easily, was laid on the floor of the cage. To prevent the animal from carrying it away, it was attached by a long chain to the outside of the cage. To lead the animal to know of the food in the pipe, small bits were placed at each end within easy reach of his fingers.

Great care was taken that the apparatus should not be seen by any animal except the one being tested, and by that only while under observation. I immediately took down all of his actions in notes.

Betty was first tried in the table experiment. Being put in at the back of the cage, she came at once to the board and looked intently at the food. She picked up the stick and pushed it out toward the food. She got the end on the food, and pushed it around, but the hook did not catch the food. She laid the stick down and looked about; she then picked it up and tried to pull it loose from the chain. She dropped it, picked it up again, and tried to push the food. The hook caught the food, and she pushed a piece over the side of the board. Again she tried, hooked a piece, and pulled it up near enough to reach it with her hand. The food was replaced, and she tried again. At the second effort she pulled the food within reach of her hand. At the next attempt she pushed the food over the side of the table. The food was replaced, and she thrust the stick out, chain end first, and was able to get the food near enough to reach it with her hand. The food was replaced, the stick lying inside the cage. At once she picked up the stick, thrust it out hook first, and speared the banana. She lifted it up on end, bringing the hook up toward the top of the cage, picked off the banana, and ate it.

Nancy learned somewhat more slowly. At first she sat at the board and looked at the food. She put out her hand to have food put into it, but, not receiving any, turned away. She came back, picked up the stick, looked it over, bit the hook, handled the chain, and laid the stick down. A moment later, when the food caught her eye, she picked up the stick and made a motion as if to thrust the stick out toward the food. She did not do so, but, laying the stick down, went back into the middle of the cage. A little later she came to the table, holding a big bunch of straw in her hand. This she thrust out toward the food, waving the straw back and forth over it. Dropping the straw, she reached for the food with her hand. Then she picked up the stick, thrust it out, and poked the food. After a little moving of the food about, she got it near enough to reach with her hand. In her second effort she did not succeed at once, and lost the stick in the performance. For some time she was inattentive to the replaced stick. Then she thrust it out, and, hooking the banana, pulled it in a little distance. Then she turned the hook end of the stick up and picked off the food.

So Betty at once, and Nancy after a little looking at the apparatus, used the stick in the best way possible. Had a human being exhibited this behavior for the first time, we should describe it most easily by saying that he perceived the relation between the food, himself, and the stick.

I should not, of course, contend that a plan of action was reasoned out, if my opponent insists on attaching to the word "reason" its old syllogistic implication. Just now I am interested in showing that the sense-impulse theory is inadequate to explain the apes' behavior. (Haggerty, 1913, pp. 151-153.)

Comparison of the behavior of the orang-outans with that of a chimpanzee in the same experimental problems indicated the inferiority of the latter. This explains the use of the word "higher" in the paragraph which follows.

My belief in the higher intelligence of the orangs was confirmed by Betty's behavior in the pipe experiment. When she was put in at the back of the cage, she came at once to the apparatus, and got the two pieces of food at the ends. Immediately after, she looked into the end of the pipe, first at the right end. She picked up the stick and tried at once to put it into the pipe. She was in her own way; she moved about and took the stick in her other hand. Climbing the bars, and holding to them with one hand and supporting herself above the level of the pipe, she took the stick in her hand and foot. She pushed the stick through the pipe and pushed the banana near the opposite end; she pulled the stick out and licked the end of it. She looked again, and tried to reach the food with her hand. She then went to the other end, saw the banana near that end, and tried to get it with her hand; but her big thumb prevented her hand entering the pipe.

Next she went for the stick and brought it to that end. The chain fastened to one end of the stick prevented her from turning the stick so as to make it enter the pipe. Not being able to put it into the pipe, she dropped it and picked up a straw, broke off a ragged end, and pushed the straw into the pipe toward the food. She pulled it out at once and threw it down; she picked up

the stick again, and renewed her efforts to get it into the pipe.

She kept up such efforts at the left end of the pipe for several minutes. Then she dropped the stick and went to the right end of the pipe. Grabbing the chain, she pulled the stick to her, and, holding to the bars with one hand as before, she took the stick in the other hand and one foot, pushed it into the pipe, and pushed the food out at the left end. She now let go of the stick, and went to the other end, and got the food which had dropped to the floor.

She was now removed while the food was replaced. When released, she came at once to the pipe, picked up the stick, and put it into the pipe at the right end as before, and pushed out the food, which she immediately picked up from the floor. The next day she got the food immediately by thrusting the stick into the pipe.

If the sense-impulse theory is unable to explain this sort of learning, it is just as wholly unable to explain such behavior as Nancy exhibited in the pipe experiment. She did not succeed in five preliminary trials, of fifteen minutes each, on successive days, but her interest continued.

At the end of the preliminary trials, the keeper entered the cage with Betty. Seating himself near the pipe, he took Nancy on his lap and held her face toward the pipe, while Betty pushed out the food. Five times she saw Betty's performance, after which she was released. At once she picked up the stick and went to the left end, where Betty had spent so much of her time. The stick was too long to be put in at that end, and she was given a stick a little shorter. This she immediately inserted and pushed food out at the right end, where she got it. Five times within a few minutes she repeated the act.

What we have here would seem to be a case of "inferential imitation." That the act was new is evidenced by the animal's repeated failures. Neither instinct, experience, nor accident availed to solve the problem. In her case we have an animal learning to do a thing otherwise than by doing it. (Haggerty, 1913, p. 154.)

In conclusion, this author states (see our page 173) that in his opinion the orang-outan perceives relations and exhibits a low order of rationality.

Although the observational opportunities of Haggerty were limited and his experiments few, they were definitely planned as tests of a hypothesis and are in a sense crucial. Because of its scientific quality this work deserves high credit and also recognition as an initial experimental study of orang-outan adaptivity.

Varied tests of the orang-outan are reported by Furness (1916), who unfortunately lacked experience as observer of behavior under carefully planned and rigidly

Fig. 66. Julius, a male orang-outan about five years old, who was subject in the experiments of Yerkes. Photographed beside the laboratory of G. V. Hamilton at Santa Barbara, California. From Yerkes, 1916.

controlled conditions. His efforts were directed chiefly to teaching his animals to recognize and react appropriately to such objects as the letters of the alphabet, geometrical forms, and certain colored surfaces. Previously his attempts to teach the orang-outan to speak have been reported (pp. 164 ff.). In that connection he observed marked ability to comprehend and respond adaptively to auditory symbols. Incidentally he gathered considerable evidence of imitative tendency, discriminative ability, perception, memory, and recognition, and noted failure of the orang-outan to learn certain acts—for example, drawing simple figures and tying knots.

Although the work of this investigator is not strictly experimental, in our opinion it deserves to be ranked with experimental studies rather than with miscellaneous naturalistic reports. There can be no question that it has values peculiar to itself, and that in spite of the multiplication of ad-

mirable experimental contributions it will long continue to be illuminating to those who desire to familiarize themselves with the orang-outan.

A third minor experimental study is that of Shepherd (1923), who, some ten years after the publication of Haggerty's report, made certain simple tests with a captive specimen. His methods indicate at once unfamiliarity with the relevant literature and with the characteristics of the animal, and his observations add nothing to previously established fact.

Bearing the same relation to experimental analysis of behavior in the orang-outan that the work of Boutan bears to that in the gibbon is Yerkes' (1916) study of ideational behavior. It was this investigator's purpose to observe and analyze adaptive behavior in the orang-outan in order to discover how novel problems are solved. To this end an original experimental situation known as the method of multiple choices was employed. The method was initially designed to yield strictly comparable objective data on the problem-solving ability of various types and conditions of organism. It enables the observer to present to his subject any of a series of relational problems which range from the simple to the extremely complex and difficult. All of the problems, however, are completely soluble, and in each case solution depends upon perception of a certain constant relation among a series of objects to which the subject is required to attend and respond. Examples of the relations which define problems are: (1) secondness from one end of the group of reaction-mechanisms; (2) middleness; and (3) alternation of end mechanisms.

It is possible to present such relational problems by means of relatively simple reaction-mechanisms. In their essential features, all of the several types of multiple-choice apparatus designed by Yerkes are the same. They consist of a series of precisely similar reaction-devices, any or all of which may be used in connection with a given observation. These reaction-mechanisms are so designed as to be suited to the structure and action-system of the subject. For most infrahuman subjects a group of similar boxes, each with an entrance and exit door,

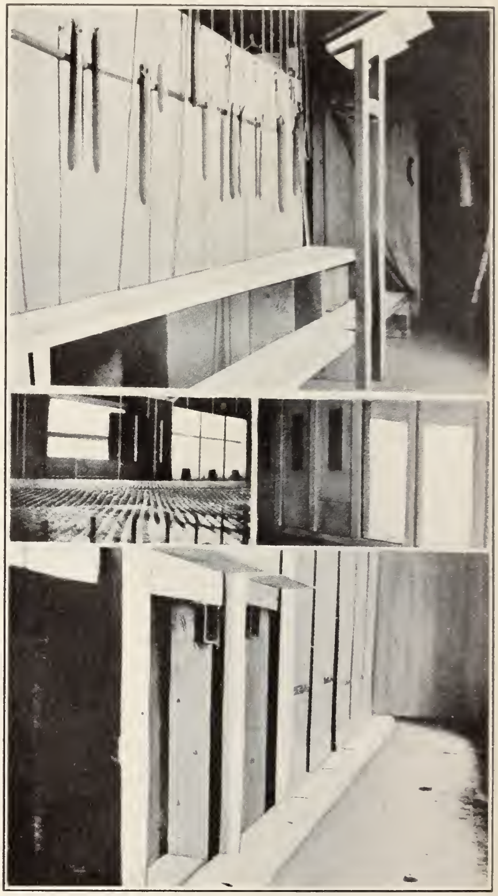


Fig. 67. Yerkes' multiple-choice apparatus, as used in study of orang-outan. From Yerkes, 1916.

has been found suitable. An incentive to selection of the right box is supplied by food, a small quantity of which is placed in a covered receptacle beyond the exit door of each of the boxes. Each time a subject enters a wrong box, it is punished for its mistake by being confined in that box for a certain time. This discourages random, hasty, or careless choices.

For the orang-outan, an apparatus, shown in figure 67, consisting of nine box-reaction-mechanisms was used to present three problems, of which the first is definable as the

first mechanism at the subject's left, the second as the second mechanism at the subject's right, and the third the first mechanism at the subject's right. The apparatus and method are fully described by Yerkes (1916, pp. 11-17).

Theoretically the method of multiple choices permits of various types of solution of any given problem, which from the human point of view vary in efficiency but not necessarily in degree of adequacy, since given the necessary amount of experience the subject in any case always responds correctly. Three possible methods of solution may be cited by way of illustration: (1) By trial and error selection of the right mechanism in any given group of mechanisms, and gradual elimination of incorrect choices; (2) by adaptation to a given group of mechanisms irrespective of its position in the apparatus; and (3) by perception of the constant relation of the right mechanism to other members of its group and reaction thereto independently of the number of mechanisms presented or their location in the apparatus. Presumably some form of imaginal or ideational process would be required for the third of these suggested methods of adaptation.

There follows a somewhat detailed account of the behavior of the subject used by Yerkes. It is offered, on the one hand, because of its uniqueness in the literature on the orang-outan, and on the other, because it is impossible to present the results in simple formula and unsafe to generalize.

The orang-outan Julius, characterized as gentle, docile, and friendly with the experimenter throughout the period of investigation, was first confronted with the multiple-choice problem of first at the left end. In other words, the subject was expected to choose from each group of reaction-mechanisms presented to him, the box at his extreme left. Quickly he adapted to the procedure of experimentation, but solution of the problem did not come promptly.

Between May 3 and May 10, no steady and consistent improvement in method or in the number of correct first choices occurred, and on the last named date, Julius chose correctly only three times in his ten trials. At this time there was, as my notes record, no satisfactory indication of progress, and the status of the experiment seemed extremely unsatisfactory in as much as in spite of the experimenter's best efforts to break up the habit of choosing the nearest door, the orang utan still persisted, to a considerable extent, in the use of this method. The only encouraging feature of the results was an evident tendency to choose somewhat nearer the left end of a group than previously.

A series of correct first choices was obtained on May 11, greatly to the surprise of the experimenter, for no indication had previously appeared of this approaching solution of the problem. It seemed possible, however, that the successes were accidental, and it was anticipated that in a control series Julius would again make mistakes. But on the following day, May 12, the presentation of the original series of ten settings, which, of course, differed radically from the settings used from May 4 to May 11 was responded to promptly, readily, and without a single mistake.

Julius had solved his problem suddenly and, in all probability, ideationally.

Only three reactive tendencies or methods appeared during Julius's work on this problem: (a) choice of the open door nearest to the starting point (sometimes the adjacent boxes were entered); (b) a tendency to avoid the "nearest" door and select instead one further toward the left end of the group; (c) direct choice of the first door on the left.

The curve of learning plotted from the daily wrong choices and presented in figure 18 [see figure 68, p. 186], had it been obtained with a human subject, would undoubtedly be described as an ideational, and possibly even as a rational curve; for its sudden drop from near the maximum to the base line strongly suggests, if it does not actually prove, insight.

Never before has a curve of learning like this been obtained from an infrahuman animal. I feel wholly justified in concluding from the evidences at hand, which have been presented as adequately as is possible without going into minutely detailed description, that the orang utan solved this simple problem ideationally. As a matter of fact, for the solution he required about four times the number of trials which Sobke required and twice as many as were necessary for Skirrl. Were we to measure the intelligence of these three animals by the number of trials needed in problem 1, Sobke clearly would rank first, Skirrl second, and Julius last of all. But other facts clearly indicate that Julius is far superior to the monkeys in intelligence. We therefore must conclude that *where very different methods of learning appear, the number of trials is not a safe criterion of intelligence.* The importance

of this conclusion for comparative and genetic psychology needs no emphasis. (Yerkes, 1916, pp. 65-68.)

Fig. 68. Error curves in a multiple-choice experiment, for the orang-outan, Julius, and the monkeys, Sobke and Skirrl. From Yerkes, 1916.

The orang-outan was given four days' rest before being confronted with the next problem, in which the right mechanism is defined as the second from the right end of the group. Again he worked faithfully, trying a variety of methods but failing to adapt perfectly and quickly. From the detailed description of his various reactive tendencies we quote the following:

On June 9 there developed a tendency to increase the magnitude of the original error by choosing nearer the left end of the groups. This is odd, since one would naturally suppose that an animal as intelligent as the orang utan would tend to avoid the general region in which success was never obtained and to focus attention on the right, as contrasted with the wrong end of each group. *It obviously contradicts the law of the gradual elimination of useless activities.* In other words, it is wholly at variance with the principle of trial and error exhibited by many infrahuman organisms. Julius, although making many mistakes, worked diligently and, for the most part, fairly rapidly. The day's work proved most important because of the change in method and also because of the appearance of hesitation, the rejection of certain boxes, and the definite choice of others. My notes record "this is a most important day for Julius in problem 2"; but subsequent results do not clearly justify this prophecy.

The method of choosing the first box at the left and then of moving down the line until the right one was reached was so consistently followed that during a number of days it was possible for me to predict almost every choice. Indeed, to satisfy my curiosity in this matter during a number of series I guessed in advance the box which would be chosen. The percentages of correct guesses ranged from ninety to one hundred. June 10, for example, yielded two series for which the ratio of right to wrong first choices was 0 to 10, and in which the method described above was used consistently throughout.

It was inevitable that punishment by confinement and the discouragement resulting therefrom should interfere with the regularity of work and make it extremely difficult to obtain strictly comparable results from series to series and from day to day. The data for this problem . . . have values quite different from those for the monkeys, chiefly because of the more variable conditions of observation.

It was occasionally noted that the disintegration of a definite method and the disappearance of the tendency on which it depended occurred rather suddenly. Frequently it happened that having used an inadequate method fairly persistently on a given day, the animal would on the following day exhibit a wholly different method. Even over night a new method might develop. In the monkeys, although there was occasionally something comparable with this, it was by no means so evident.

After two hundred and fifty trials on problem 2 had been given Julius, it seemed desirable to introduce a radical change in method in order to stimulate him to maximal effort. It was therefore decided to force him to make a round trip through the apparatus in connection with each choice, and to let this forced labor serve, in the place of confinement, as punishment for mistakes. This new method yielded peculiar and characteristic results. They differ from those previously obtained largely because of the orang utan's remarkably strong tendency to reënter the box through which he had just passed. This occurred so persistently . . . that a further modification of method was introduced in that after the same wrong box had been entered five times in succession, the experimenter on the next choice of the box confined the animal for a stated interval, say sixty seconds, in it, and then allowed it to escape by way of the exit door and choose repeatedly until it finally located the right box. Were it not for this particular feature of the method, the number of choices recorded after June 17 would unquestionably be very much greater. . . .

The new method proved a severe test of the orang utan's patience and perseverance, for he had to work much harder than formerly for his reward, and often became much fatigued before completing the regular series of ten trials. Early in the use of this method, he developed the habit of

rolling around from exit door to starting point by a series of somersaults. When especially discouraged he would often bump his head against the floor so hard that I could hear the dull thud. As has been noted, I found it desirable to vary the procedure repeatedly. It proved especially interesting to give one series per day with the round trip as punishment and another series with confinement as punishment.

Day after day, as the experiment progressed, slight or great fluctuations of the ratios of right to wrong choices appeared, but without consistent improvement. There was, to be sure, . . . a radical improvement during the first six hundred and fifty trials, for the number of right choices per series increased from 0 to 8. But, as the observations were continued from day to day, it became more and more evident that the animal was merely passing from tendency to tendency—method to method—mixing tendencies, and occasionally developing new ones, without approach to the solution of the problem. This fact would have led me to discontinue the work much earlier than I actually did had it not been for the peculiarity of the results obtained with problem 1. It seemed not improbable that at any time Julius might succeed in perfectly solving this problem over night precisely as he had solved the first problem.

A curiously interesting bit of behavior appeared for the first time on June 29. Julius had gone to the first box at the right end of the group, and instead of entering, he had wheeled around toward his right, and turning a complete circle, faced the right box, which he promptly entered. Subsequently, the tendency developed and the method was used with increasing frequency. On June 30, it appeared in the first series, four times, in the second series, six times; on July 1, in the first series, three times, and in the second series, four times; on July 2, in the first series, five times, and in the second series, nine times. It was indeed only by accident that the animal failed to fulfill the technical requirement for perfect solution of the problem in this series. Yet, had he done so, his subsequent trials would doubtless have revealed the lack of any other idea than that of turning completely around before entering a box.

This odd bit of behavior proved peculiarly interesting and significant in that the tendency to turn became dissociated from the position (in front of the first box at the right end of the group) in connection with which it originally developed. After a few days, Julius would enter the reaction-chamber and instead of proceeding directly to the right end of the group, would stop suddenly wherever he happened to be, turn toward his right in a complete circle, and hasten into the box nearest to him which, as often as not, proved to be the wrong one. Thus the idea of turning completely about, which had it continued its association with the idea of facing the first box at the right, would have yielded success, instead became useless because of its dissociation.

That the orang utan is capable of using free ideas seems clear enough in the light of this behavior. That he proved incapable of getting the idea of second from the right end is as clearly shown by the detailed results . . . the fruits of weeks of experimenting. (Yerkes, 1916, pp. 73-83.)

Despite 1,380 trials in multiple-choice problem 2, Julius failed to achieve solution.

A third problem, in which the correct mechanism was the first at the subject's right, was presented with the thought that Julius might solve it as he did the initial problem, but instead he tended to choose the box which was second from the right end and, therefore, correct for the preceding problem. Shortly his behavior began to indicate extreme discouragement, and the investigator states:

It was obviously useless to continue the experiment further since Julius had given up his attempts to locate the right box in the first choice and was apparently satisfied to discover it by a process of trial and error. He had, it would seem, satisfied himself that the problem was insoluble. These results obtained in problem 1a constitute a most interesting comment on the effects of problem 2 on the orang utan. Behavior similar to that which he developed well might have been obtained from a child of three to four years placed in a like situation and forced to strive, day after day, to solve a problem beyond its ideational capacity.

In many respects the most interesting and to the experimenter the most surprising result of this long series of observations with Julius was the lack of consistent improvement. It seemed almost incredible that he should continue, day after day, to make incorrect choices in a particular setting while choosing correctly in some other setting which from the standpoint of the experimenter was not more difficult.

The evidence suggests that in this young orang utan ideational learning tended to replace the simpler mode of problem solution by trial and error. Seemingly incapable of solving his problems by the lower grade process, he strove persistently, and often vainly, to gain insight. He used ideas ineffectively. Animals far lower in intelligence (e.g., the pig), surpass him in ability to solve these relational problems because they use the method of elimination by trial consistently and effectively. Julius, in these experiments, made a poor showing because his substitute for trial and error is only slightly developed. Would he have succeeded better with the same problems if mentally mature? (Yerkes, 1916, pp. 85-87.)

Discussion of the adaptive behavior of the orang-outan in the multiple-choice situation is needless. The principal facts have been presented and their interpretation or evaluation will continue uncertain until the subject is more thoroughly investigated. That much of the behavior is different from the sense-impulse type of adaptation referred to by Haggerty is certain, and to us it seems equally certain that many acts indicate imaginal or ideational processes.

In supplementation of the multiple-choice experiments, Yerkes made certain somewhat less systematic tests of adaptive ability. From the technical point of view these tests are less satisfactory because less exactly describable than the experiments previously noted. But their results are in some respects more interesting, and they are possibly even more important in the light which they throw on ideation than are those yielded by the method of multiple choices.

First to be described is what was designated as the box-stacking experiment. In a large cage a banana was suspended approximately six feet from the floor and not less than five feet from any side of the cage. Two boxes were placed on the floor of the cage several feet from the point directly beneath the banana. So far as the experimenter could foresee, the only way in which Julius could obtain the banana was by placing the boxes, the one upon the other, nearly under it.

At 10 A.M. on March 5, Julius was admitted to the large cage, and the banana was pointed out to him by the experimenter. He immediately set about trying to get it, and worked diligently during the whole of the period of observation, which, because of the unfinished condition of some of the cages, was limited to slightly over ten minutes. Within this period he made upward of a dozen fairly well directed attempts to obtain the food. Chief among them were three attempts to reach the banana from different positions on the left wall of the cage (as the experimenter faced the laboratory); two attempts to reach it from different positions on the right wall; two from the large box in positions nearly under the banana; two from the large box with the aid of the experimenter's hand; and one from the distant end of the cage (?). There occurred, also, less definite and easily describable efforts to get at the reward.

On account of the unfinished condition of the cages, the experimenter had to remain in the large cage with Julius during the test. This interfered with the experiment because the animal tended both to try to escape and to get the experimenter to help him with his task. Particularly interesting is the latter sort of behavior. After the orang utan had made two or three futile attempts to obtain the food he came to the experimenter, who was standing in one corner of the cage, took him by the hand, and led him to a point directly under the banana. He then looked up toward the banana, grasped the experimenter's arm, raised it, and then tried to pull himself up. He was not allowed to get the food by climbing up on the experimenter. A few minutes later, he again led the experimenter toward the banana, but receiving discouragement in this activity, he proceeded to devote himself to other methods.

Apart from the distractions which have been mentioned above, Julius's attention to the food was surprisingly constant. Whatever his position with respect to it, he seemed not for an instant to lose his motive, and to whatever part of the cage he went and whatever he did during the interval of observation was evidently guided by the strong desire to obtain the banana. Frequently he would look directly at it for a few seconds and then try some new method of reaching it. His gaze was deliberate and in the handling of the boxes he accurately gauged distances. Several times he succeeded in placing the larger box almost directly under the banana, and repeatedly he located that portion of the side wall from which he could most nearly reach the coveted prize.

From my notes I quote the following comment on the results of the initial experiment: "Despite all that has been written concerning the intelligent behavior of the orang utan, I was amazed by Julius's behavior this morning, for it was far more deliberate and apparently reflective as well as more persistently directed toward the goal than I had anticipated. I had looked for sporadic attempts to obtain the banana, with speedy discouragement and such fluctuations of attention as would be exhibited by a child of two to four years. But in less than ten minutes Julius made at least ten obvious and well directed attempts to reach the food. There were also wanderings, efforts to obtain aid from the experimenter, and varied attempts to escape from the cage." (Yerkes, 1916, pp. 89-91.)

There follows comparison of the work of Julius in this problem with that of a boy forty months of age, which is summed up by the statement that the behavior of the child indicates a greater variety of ideas than that of the orang-outan.

Continuing description of the ape's efforts to solve this problem in later tests, the investigator writes:

As previously, the steadiness of attention and the persistence of effort toward the end in view were most surprising. At one time Julius walked to the end of the cage and there happened to see one of the monkeys eating. He watched intently a few seconds and then hastened back to the banana as if his task had been suggested to him by the sight of the feeding animal.

Most interesting and significant in this behavior was the suddenness with which he would turn to a new method. It often looked precisely as though a new idea had come to him, and he was all eagerness to try it out.

On March 11, Julius was given another opportunity to obtain the banana by the use of the three boxes. Although he used them together he made no effort to place one upon another. . . .

He handled the boxes conspicuously well, and it seemed at times that he would certainly succeed in placing the one upon the other and in reaching the food.

After one series of attempts from the sides of the cage and from the large box, he deliberately turned away from the box and neatly executed a somersault on the floor of the cage, as much as to say, "I am disgusted with the whole situation." Again, later on the same day, after falling from the top of the larger box, which tilted over very easily, he rolled himself into a ball, and childlike, played with his feet. An additional evidence of his changed affective attitude toward his task, especially in connection with definite failures, appeared in his rough handling and biting of the boxes. When most impatient, he worked very roughly.

Julius was allowed to work for the reward from thirty to ninety minutes, or, as a rule, until he had become completely discouraged on April 3, 5, 6, 7, 8, 9 and 13. His behavior was interesting and significant, but nothing new appeared except that his willingness to work gradually disappeared, and on April 13, although previously hungry, he made only a single attempt to obtain the banana and then paid no further attention to it. (Pp. 93-94.)

As the orang-outan had failed after abundant opportunity to solve the box-stacking problem, it was decided to test his ability to adapt by imitation. The procedure was as follows:

On the morning of April 14, having placed a banana in the usual position, I took Julius into the large cage, dragged the two boxes to the proper position beneath the banana, placed the smaller one upon the larger one and then climbed up on them to show the ape that I could reach the banana. I then stepped down and gave him a chance to climb on the boxes. He did so immediately and obtained the food.

Another piece of banana was supplied, the boxes were placed in distant corners of the cage, and fifteen minutes were allowed Julius so to place them that he could obtain his reward. He gave no indications of having profited by my demonstration, but worked with the boxes singly, usually with the larger one. (P. 95.)

On April 16 and 17 opportunity for imitative learning was offered, but despite the obviously encouraging influence of the demonstration the orang-outan failed to use the boxes together.

On April 19 the boxes were properly placed, the animal permitted to obtain the reward, and the experimental situation then reset.

This time he [Julius] immediately reached for the smaller box and moved it about a little, thus indicating a new association. He next turned to the larger box and worked with it persistently. Later, he once more worked with the smaller box in an unusual manner. He repeatedly stood on it, but made no attempt to lift it or to place it on the larger box. Clearly the usually neglected smaller box had become associated with the satisfaction of obtaining the banana. The same method was carried out on April 20. As I placed the boxes in position beneath the banana, Julius watched with unusual intentness, and when it came his turn to try to obtain the food by the use of the boxes, he began at once to work with the smaller box, but as on April 19, he soon abandoned it and turned to the other. While I was making note of this particular feature of his behavior, he suddenly seized the smaller box by two corners with his hands and by one edge with his teeth, and after a few attempts placed it on top of the larger box, climbed up, and obtained the banana.

Because of bad weather on April 21, the next test was made on April 22, with everything as usual. Unaided, the ape was given an opportunity to obtain the coveted reward, while I stood ready to obtain records of his behavior with my camera. He wasted no time, but piled the smaller box on top of the larger one immediately, and obtained his reward. As soon as opportunity was offered, he repeated the performance. The same thing happened on April 23 and several succeeding dates.

Julius had got the idea, and the only further improvement possible was in skill in manipulating the boxes.

. . . .

Obviously important is the evident change in the animal's attention on April 20. He watched

with a keenness of interest which betokened a dawning idea. Before he had succeeded in stacking the boxes, I had written in my note-book, "He seemed much interested today, in my placing of the boxes." Interesting, and important also, is the ease and efficiency with which he met the situation time after time, after this first success. "Trial and error" had no obvious part in the development of the really essential features of the behavior. The ape had the idea and upon it depended for guidance.

. . . .

No unprejudiced psychologist would be likely to interpret the activities of the orang utan in the box-stacking experiment as other than imaginal or ideational. He went directly, and in the most business-like way from point to point, from method to method, trying in turn and more or less persistently or repeatedly, almost all of the possible ways of obtaining the coveted food. The fact that he did not happen upon the only certain road to success is surprising indeed in view of the many ineffective methods which he used. It seemed almost as though he avoided the easy method.

It is especially important, in connection with these results, to point out the risk of misinterpretation of observations on the anthropoid apes. If they can imitate human activities as readily and effectively as Julius did in this particular experiment, we can never be sure of the spontaneity of their ideational behavior unless we definitely know that they have had no opportunity to see human beings perform similar acts.

Of all the methods of eliciting ideational or allied forms of behavior used in my study of the monkeys and ape, none yielded such illuminating results as the box-stacking test, and although from the technical standpoint, it has many shortcomings, as a means to qualitative results it has proved invaluable. (Yerkes, 1916, pp. 96-98.)

In the box-stacking situation, but with the boxes lacking, the orang-outan was subsequently given opportunity to use a stick to obtain the desired food. In this he succeeded, but in ways not expected by the observer. For instead of striking the banana with the stick and thus detaching it, he used the stick to climb upon or, thrusting it into the side of the cage, to swing out on until he was able to reach the lure. Versatility and resourcefulness are terms which well describe the impression made on the observer by the animal's behavior.

The problem called by Yerkes the box-and-pole experiment, which is essentially like the pipe-and-stick test used by Haggerty (our p. 182), was next presented to Julius. A strong wooden box eighty-four inches long, four inches wide, and four inches deep, with open ends, was built with one side hinged. Hasps and padlocks enabled the experimenter to lock this "lid" after food had been placed in the center of the box. In preparation for the experiment this long box was securely fastened in the center of a large cage, and several feet away from it on the floor of the cage were two poles each about eight feet long and approximately one and one-half inches in their other dimensions. It was desired to discover whether the orang-outan would of his own initiative use a pole to push the food out of the box.

On May 1, Julius was allowed to see the experimenter place a half banana in this box, close the lid, lock it in position, and securely fasten the box by means of the cross bars. He was then given opportunity to try to get the banana. The two poles lay on opposite sides of the box and near the edges of the cage. Doctor Hamilton and the writer were in the cage watching. Julius looked into the box through one end, and seeing the banana, reached for it. He could not obtain it in this way, so he began to bite at the box and to pull at it with all his strength. During the fifteen minutes allowed him, he worked at the box in a great variety of ways, fooling with the locks which had been attached to the hasps as well as with the cross bars and continually reaching in at the one or the other end. He was somewhat distracted by the presence of the two observers and attended rather unsatisfactorily to the task in hand. Not once did he touch the poles, and it is doubtful whether he even noticed them. He was not very hungry at this time, and after a few minutes active work he virtually gave up trying to get the food.

Two days later, on May 3, the box was once more placed in position, this time with a half banana in the middle and a small piece of banana near each open end. The two poles lay on the floor of the cage, each several feet distant from the box. Julius was eager for food. When released he went immediately to the box, reached in and obtained a piece of banana from the end nearer the laboratory. He then looked in and saw the piece near the middle of the box. His next move was to pick up the eight foot pole and push it into the box, but before pushing it all the way through, he stopped and began to pull at the box in various ways. Shortly he returned to the pole and twice thrust it in as far as he could reach. The first time, after thrusting it all the way through, he pulled it out and examined the end as though expecting the

banana to come out with it. After a third attempt he looked into the box, presumably seeing the banana, then turned a backward somersault, came to the end of the cage, and looked at me. Had it been at all possible, he would have taken me by the hand and led me to the box as a helper. After a few seconds, he returned to the pole, pried the lid of the box with it, then gnawed at the pole. For about five minutes he worked fairly rapidly and steadily, using the poles, pulling, gnawing, and walking about.

His next move was to go to the opposite end of the box, look in, take the piece of banana which was near the opening, then pick up the second pole, which had not previously been noticed, and after a number of attempts, push it into and through the box, looking after it and then pulling it out and looking into the box. Having done this he again came to my end of the cage, and from there returned to try once more with the pole which he had first used. He pushed this pole all the way through, then walked to the other end of the box, looked in and reaching in, obtained the banana which had been pushed far enough along to be within his grasp.

Julius had worked twenty-four minutes with relatively little lost time before succeeding. He had shown almost from the start the idea of using the pole as an instrument, and his sole difficulty was in making the pole serve the desired purpose.

The experiment was rendered still more crucial on May 5 by the placing of the two poles upright in opposite corners of the large cage. For a few minutes after he entered the cage, Julius did not see them, and his time was spent pulling and gnawing at the box. Then he discovered one of the poles, seized it, and pushed it into the box. He tried four times, then went and got the other pole and pushed it into the opposite end of the box. Twice he did this, then he returned to the original pole, bringing the second one with him. He pushed it in beside the first, and as it happened, shoved the banana out of the opposite end of the box. But he did not see this, and only after several seconds when he happened to walk to that end of the box did he discover the banana. The total time until success was fifteen minutes.

Subsequently the ape became very expert in using the pole to obtain the banana, and often only a minute or two sufficed for success. It was not possible for him to direct the stick very accurately, for when he was in such a position that he could look through the box, he could not work the stick itself. It was, therefore, always a matter of chance whether he obtained the banana immediately or only after a number of trials.

Although it is possible that the use of the poles in this experiment was due to observation of human activities, it seems probable in the light of what we know of the natural behavior of the anthropoid apes that Julius would have solved this problem independently of human influence. It was the expectation of the experimenter that the pole would be used to push the banana through the box, but as a matter of fact the ape used it, first of all, to pull the food toward him, thus indicating a natural tendency which is important in connection with the statements just made. Subsequently he learned that the banana must be pushed through and obtained at the farther end of the box. I am not prepared to accept the solution of this problem as satisfactory evidence of ideation, but I do know that few observers could have watched the behavior of the orang utan without being convinced that he was acting ideationally. (Yerkes, 1916, pp. 99-102.)

In a form of experiment similar to one later used by Shepherd (1923, p. 590), but more difficult than his, Yerkes tested the ability of Julius to use a stick as tool in obtaining objects which were placed beyond his reach on a platform outside of his cage.

When this situation was first presented to Julius, he looked at the banana, reached for it, and failing, picked up a bag from the floor of the cage and tried to push it through the wire mesh toward the banana. He also used a bit of wire in the same way, but was unable thus to get the food. As soon as a stick was placed in his cage, he grasped it and used it in a very definite, although unskillful, way to pull the banana toward him. He was extremely eager and impatient, but nevertheless persistent in his efforts, and within five minutes from the beginning of the first trial, he had succeeded in getting two pieces of banana, using always his left hand to manipulate the stick. This test was repeated a number of times with similar results. He had from the first the ability to use a stick in this way, and the only difficulty with the test as a means of obtaining evidence of ideational behavior is that the possibility of imitation of man cannot be certainly excluded. (P. 102.)

Attempt was made also to use the lock and key as a means of exhibiting adaptation to a novel type of mechanical problem, but the result as indicated below was, in the main, negative.

By my assistant it was reported on May 5 that the orang utan had been seen to place a splinter of wood in a padlock which was used on the cages and to work with it persistently. It looked very much like imitation of the human act of using the key, and I therefore planned a test to ascertain whether Julius could readily and skillfully use a key or could learn quickly to do so by watching me.

The first test was made on May 15 with a heavy

box whose hinged lid was held securely in position by means of a hasp and a padlock. The key, which was not more than an inch in length, was fastened to a six inch piece of wire so that Julius could not readily lose it. With the animal opposite me, I placed a piece of banana in the box, then closed the lid and snapped the padlock. I next handed Julius the key. He immediately laid it on the floor opposite him and began biting the box, rolling it around, and occasionally biting also at the lock and pulling at it. During these activities he had pulled the box toward his cage. Now he suddenly looked up to the position where the banana had been suspended in the box experiment. Evidently the box had suggested to him the banana. For thirty minutes he struggled with the box almost continuously, chewing persistently at the hinges, the hasp, or the lock. Then he took the key in his teeth and tried to push it into one of the hinges, then into the crack beneath the lid of the box.

Subsequently I allowed him to see me use the key repeatedly, and as a result, he came to use it himself now and then on the edge of the box, but he never succeeded in placing it in the lock, and the outcome of the experiment was total failure on the part of the animal to unfasten the lock of his own initiative or to learn to use the key by watching me do so. I did not make any special attempt to teach him to use the key, but merely gave him opportunity to imitate, and it is by no means impossible that he would have succeeded had the key been larger and had the situation required less accurately coördinated movements. However, it is fair to say that the evidence of the idea of using the key in the lock was unconvincing. My assistant's observation was, perhaps, misleading in so far as it suggested that idea. It may and probably was purely by accident that the animal used the splinter on the padlock. (Yerkes, 1916, pp. 102-103.)

For general comparison of modes and degrees of behavioral adaptivity, designated "intelligence," Drescher and Trendelenburg (1927) experimented with certain specimens of cats, dogs, monkeys, and anthropoid apes. Among their subjects, which included also one gibbon and five chimpanzees, were four orang-outans, the estimated ages of which ranged from two to four years. All were zoölogical garden specimens (p. 615). One or more of the orang-outans was used in each of the following types of experimental test: (1) Use of rake as instrument to draw in food; (2) use of turntable to bring food within reach; (3) use of string or pole to obtain food; (4) removal of obstruction in path to food or freedom; (5) opening of lid of box which contained food; and (6) the unbolting of lid of food-containing box.

In the rake test an orang-outan first exhibited interest in the rake itself, which it examined with nose and tongue. Thereupon it so manipulated the object as to push it through the bars of its cage and, properly orienting it, used it immediately and with clear intent, although at first unskilfully, to draw food within reach. The authors especially note the superiority of their monkey subjects to the orang-outan in manual skill and their inferiority in "understanding or insight" (p. 618). Similarly, success was achieved by the orang-outans in the turntable experiment (p. 619).

Of the solution of the string-and-pole types of test the observers remark that the orang-outan solved its problems smoothly, and that the direction of its gaze and its eye movements clearly enough indicate its observation and appreciation of the relations of string or pole to the desired reward (p. 619).

Obstacles were promptly and immediately removed by two orang-outan subjects in order that food might be obtained. The observers state that the behavior of one specimen was "full of purpose" and that another immediately and skilfully solved the problem of removing an obstructing box (p. 620). Three orang-outans were observed to solve the closed-box problem readily. The authors' description of orang-outan behavior in the bolted-box test seemingly indicates inadequacy of motivation, for they state that the behavior of their subjects gave the impression that they were too phlegmatic to exert themselves. They manipulated the bolt or bolts and in general manifested stronger interest in the mechanical device than in the prospective reward. Ability to solve the problem was exhibited by one subject, but in the case of another, failure resulted, despite efforts at tuition.

These experiments cannot be highly valued because conducted with subjects whose experience with like situations was

entirely unknown, and under conditions which rendered satisfactory controls virtually impossible. Probably the general conclusions formulated by the authors are based even more largely upon the findings of other investigators than upon their own experiments. In any event, they are of extraordinary interest and worthy of careful, critical consideration. We quote their concluding sentences:

> Further, the anthropoids [great apes] show a greater primary ability to comprehend changes in the arrangement of the experiments, a slighter adherence to what they have been accustomed to in the previous experiments. Finally, the whole psychic equipment of the apes as contrasted with man is wholly different from that of the monkeys, if one takes account of the clear results of adjustment. Need of help is always much greater in the younger anthropoid apes than in the monkeys. Also they have much greater possibilities of expression, both in play of features and in the sounds of their voices. (Drescher and Trendelenburg, 1927, p. 642.)

In the literature there are many references to the apparent use of objects as instruments by orang-outans, but in most instances the conditions of observation were unsatisfactory, and the observer's ignorance of the previous experience of his subject renders interpretation of behavior impossible. Among the authors who have incidentally contributed to this subject are: Vosmaer (1778), Wurmb (1798), F. Cuvier (1811), Wallace (1856a, 1869), Schmidt (1878), Reuvens (1889), Camacho (1907), Sokolowsky (1908), Knauer (1915), Hornaday (1922), Sheak (1922, 1923), while in the general works of Rennie (1838), Martin (1841), and Heck (1922) may be found several pertinent citations or descriptions.

Evidences of ideational processes supplemental to those presented by Haggerty, Yerkes, and Drescher and Trendelenburg, and afforded by certain descriptions of the use of objects as tools, appear in various reports of naturalistic, as contrasted with experimental, studies of the behavior of the orang-outan. Two cases will serve as illustrative examples.

Montgomerie is quoted by Grant (1828, p. 4) as observing in the orang-outan occasionally a facial expression which suggested the presence of "some pleasant idea." And Schmidt (1878, pp. 357-358) among varied evidences of imaginal behavior describes anticipatory action, for the animal in question, according to this observer, adapted its movements to what it expected of its chimpanzee companion.

In each of these cases description is brief and of uncertain value because of lack of information concerning the genetic relations of the acts. This criticism unfortunately holds of almost all naturalistic accounts of anthropoid behavior, and the weakness can be avoided only by continuous and systematic observation of the activities of an individual throughout life—a task which is usually impracticable and in many instances impossible.

Memory in the orang-outan has not been intensively studied. Casual and incidental observations seemingly justify the statement that it is excellent. From the following reports it is to be inferred that the temporal span may exceed a year. In a seven-year female Priemel (1908, p. 83) noted memory of favorite localities or spots from season to season. Recognition of persons after absence of a year is reported by Sokolowsky (1908, p. 59); and Furness (1916, p. 286) says that six months after instruction ceased "my apes had forgotten nothing."

In final summary and evaluation of materials on behavioral adaptivity in the orang-outan it may fairly be stated that whereas information about receptivity and perception is scanty, there is more ample, although still very general and wholly inadequate, knowledge of certain aspects of habit-formation. There are, it appears, several modes of adaptation in the orang-outan. Among those which may be accepted as definitely demonstrated and whose importance is considerable are: (1) adaptation by imitative response, the nature of which varies through a number of types; (2) adaptation by trial of various possible responses and gradual elimination of injurious or unprofitable acts (the sense-impulse mode of habit-formation

described by Thorndike); (3) adaptation by selective perceptual process and elimination of certain useless acts without trial; and (4) adaptation with a measure of understanding, insight, or ideation.

Analysis of modes of activity in the orang-outan is obviously incomplete and the descriptive data few and entirely inadequate for scientific needs. Nevertheless, it is clear that important investigations have been inaugurated and profitable directions of research discovered.

The orang-outan appears to represent a considerably higher level of psychobiological development than the gibbon. To use a lay term, it is obviously more intelligent; to employ a technical term, it is more highly adaptable in respect to behavior, exhibits more varied modes of adaptation and more abundant evidence of understanding, insight, and in general of the functioning of representative processes.

Of the publications listed in our general bibliography the following have in one way or another aided us in preparing this account of the life of the orang-outan: Abel (1818, 1825), Aldrovandi (1637), Audebert (1800), Bauman (1923), Blumenbach (1775, 1825), Blyth (1841a, 1847, 1853), Boitard (1842), Bolau (1894), Bontius (1658), Brehm (1922), Broderip (1849), Brooke (1841), Buffon (1766, 1789), Camacho (1907), Camper (1779, 1779a), Cuvier, F. (1811), Cuvier, G. (1831), Delisle (1893), Deniker (1882), Descamps (1920), Drescher and Trendelenburg (1927), Elliot (1913), Fick (1895, 1895a), Fitzinger (1853), Fox (1929), Friedel (1876), Furness (1916), Forbes (1894), Garner (1892a, 1900), Grant (1828), Haggerty (1910, 1913), Hartmann (1880, 1885), Heck (1922), Hermes (1876), Hoppius (1760), Hornaday (1879, 1885, 1922), Huxley (1863), Jeffries (1825), Jones (1916), Keith (1895, 1896, 1914), Kerbert (1914), Knauer (1915), Lawrence (1848), Le Comte (1697), Leguat (1708), Lenz (1895, 1895a), Linnaeus (1766), Lydekker (1894, 1897), Martin (1841), Mayer (1923), Milne-Edwards (1895), Mitchell, P. Chalmers (1902-04, 1912), Mollison (1908, 1910-11, 1914-15), Nissle (1873), d'Obsonville (1783), Pennant (1781), Pfungst (1912), Pocock (1906), Priemel (1908), Radermacher (1780?), Rennie (1838), Reuvens (1889), Rudolphi (1824), St. John (1862), Schlegel (1876), Schlegel and Müller (1839-44), Schmidt (1878), Schouten (1707), Sclater (1891), Shaw (1800), Sheak (1922, 1923), Shelford (1916), Shepherd (1923), Sokolowsky (1908, 1915, 1923), Sonntag (1924, 1924a), Stiles and Orleman (1927), Temminck (1835-41), Vosmaer (1778), Wallace (1856, 1856a, 1869), Warwick (1832), Waterton (1870), Wurmb (1781, 1798), Yerkes (1916, 1925).

PART IV

CHIMPANZEE

CHIMPANZEE

CHAPTER SEVENTEEN

STRUCTURAL APPEARANCE, SPECIES, DISTRIBUTION, AND HABITAT OF CHIMPANZEE

CHARACTERISTICS OF OUR KNOWLEDGE OF THE TYPE

THE literature on the chimpanzee numbers hundreds of titles; undoubtedly it is the largest for an anthropoid type. In order of increasing frequency of titles the forms rank: gibbon, gorilla, orang-outan, chimpanzee. This order holds also for psychobiological studies, both naturalistic and experimental, and it further in all probability indicates the extent and reliability of knowledge of the characteristics of the several anthropoid apes.

Of the status of morphological description, Keith some thirty years ago wrote:

> There is to be found in literature the description of parts belonging to over two hundred chimpanzees, but of that great number the anatomy of only one animal has been described with an approximation to completeness, that of Gratiolet (1866), and even it lacks much. (Keith, 1896, p. 250.)

Even as Keith wrote this sentence Sperino (1897) was publishing a description of the structure of a specimen, complete save for the omission of skeleton and glands, and with extensive bibliography.

Writing a quarter of a century later, Sonntag remarks that although parts of some three hundred chimpanzees had been described, prior to his own contribution, the anatomy of only one had been presented with approximation to completeness (Sonntag, 1923, p. 323).

Examination of recent morphological bibliographies and general acquaintance with the literature convince us that these statements are indicative of the gross inadequacy of anatomical descriptions of individual and species.

Incomplete and inaccurate, even by comparison with the morphology whose unsatisfactoriness Keith laments, are physiological, behavioral, and psychological descriptions. Despite the vast literature on the chimpanzee, we know most aspects of its life only partially and uncertainly. Not a single specimen has been studied throughout its life history or at any given period of development with reasonable thoroughness. Nevertheless, so abundant are the fragments of psychobiological information that we are greatly embarrassed in the attempt to present the substance of knowledge briefly. For the gibbon our task was rendered difficult by the paucity of trustworthy information; for the orang-outan, by great gaps and the relative lack of reliable naturalistic or experimental studies in psychobiology. The opposite is true of the chimpanzee. Yet in spite of the deficiencies and defects in materials, it should be possible to give a much more useful and more nearly complete and reliable account of it than of any other anthropoid ape. On the natural history—considered as ecological relations, mode of life, and natural action system—of the chimpanzee there is a relatively excellent literature, and of both field and laboratory studies in behavior and mentality there are many as compared with the few for the other anthropoids. In view of these facts, the wonder is that our knowledge of any and every aspect of the chimpanzee's life remains so inadequate to the requirements of precise description and also of intelligent attempts to modify and control it.

HISTORICAL SUMMARY

FITTING as an introduction to a summary account of chimpanzee traits, based primarily upon the literature of the last seventy-five years, is a *résumé* of the historical part of this volume, so far as the chimpanzee is subject of inquiry. A few sentences will suffice to summarize the history of scientific acquaintance with the animal.

Fig. 69. Adult male chimpanzee of the species *Pan schweinfurthii.* Courtesy of Herbert Lang and American Museum of Natural History.

Doubtful in the extreme is definite acquaintance with the ape by the ancients. The "gorillae" of Hanno may have been chimpanzees, gorillas, or wild men; and no certain mention of this African anthropoid is to be found in Aristotle, Pliny, or Galen.

Some fifteen centuries after the period of Galen there appears in Pigafetta (1591, p. 53 of 1881 ed.) reference to apes and monkeys in the "Songo" of Africa. That among the apes it was intended to include the chimpanzee is probable but cannot be proved. The historian Gesner (1551) presents in his descriptions of "Simiae, Satyrs, and Sphinges" materials which probably justify the inference that the smaller at least of the two African apes was then known to scientists. And the same statement is applicable to the historical work of Aldrovandi (1637).

It is, however, in Battell's account of the Pongo and Engeco of Africa (Purchas, 1625) that we are first enabled to identify the chimpanzee in contrast with the gorilla. Scientific description of the type begins with Tulp (1641). A few decades later Dapper (1686) wrote of the behavior of the Quojas-morrou, certainly the chimpanzee.

Relatively permanent and reliable descriptive contribution was first made by Tyson (1699), who from careful dissection minutely described a chimpanzee. He, however, named it "orang-outang." Tyson's *The Anatomy of a Pygmie Compared with That of a Monkey, an Ape, and a Man* is a historical landmark, from which the development of increasingly reliable scientific knowledge of the chimpanzee may be traced.

Omission of the group of taxonomists from this summary would be inexcusable, for although most of them contributed little to information about the life of anthropoid apes, they nevertheless prepared the way for the recognition of types and thus reduced prevalent confusion. Outstanding in this group by reason of the scientific quality and historical relations of their

Fig. 70. Adult female chimpanzee of the species *Pan schweinfurthii.* Courtesy of Herbert Lang and American Museum of Natural History.

work are Ray, Linnaeus, Buffon, and G. Cuvier.

Throughout the eighteenth century, despite Tyson's epoch-making contribution, the chimpanzee continued to be commonly confused with the orang-outan, the one being known as the black and the other as the red variety. Names which perhaps deserve mention during the period of lessening confusion are: de la Brosse (1738), Boreman (1739), the Earl of Egmont (date of manuscript 1739-47, published in 1923), Scotin (1739), Edwards (1758-64), Monboddo (1774), Blumenbach (1775), Daubenton (1782-1825), Audebert (1800), and Shaw (1800).

During the first half of the nineteenth century the orang-outan and chimpanzee came to be definitely and usually distinguished, and before the end of the century the four existent types of anthropoid ape were established by authoritative descriptions and confusion had entirely disappeared.

It is doubtless largely because of the striking similarity in structure and size of the Asiatic orang-outan and the African chimpanzee that the two were first considered representatives of a single type and were thereafter long confused by scientists as varieties of "orang-outang."

First among recorded specimens of chimpanzee to arrive alive in Europe is one sent from Angola to Holland. It was presented to Frederic Henry, Prince of Orange, and in 1641 described by Tulp.

Of early specimens said to have been brought to England alive Martin (1841, pp. 379 ff.) gives an account. The first, the specimen later dissected by Tyson (1699) arrived in 1698. The second, an equally famous example to which there are many references in the literature, and in this volume, dates from 1738. The third individual to reach England came in 1818. Because it subsequently was dissected by him, it is known as the Traill specimen. In 1819 arrived the fourth, and in 1832 the fifth example. Both of these became the property of the animal dealer Cross. The 1832 individual is the subject of Warwick's description of "habits and manners." The individual, so interestingly described by Broderip, came in 1835 as the sixth in this list.

Of the many specimens which arrived in Europe between 1750 and 1850 presumably several must have been alive.

STRUCTURAL CHARACTERS

To the rule that the general appearance of a manlike ape changes radically in the course of its life history, largely by reason of the development of primary and secondary sexual characters, the chimpanzee is no exception. Description of the configuration of the type chimpanzee is as difficult as description of man, so numerous and pronounced are individual, sex, and species differences and developmental changes. The more diligently one strives for adequate description, the more strongly he is impressed by the fewness of universally applicable terms. Thus, for example, by one or another authority the chimpanzee is said to possess a flat and an arched occiput, small and large, close-set and outstanding ears, light and dark skin, slender and stubby fingers. But most discouraging of all, when one's task of general description has been accomplished, it is, like a behaviorist's description of emotion, something which does not remotely suggest its object. Doubtless in the case of the chimpanzee this is because we never see the type. It is, in fact, a composite of individuals which possesses the characteristics of no one of them.

The following configurational description applies only to the adult. The range of specific and individual differences is very large. Like the orang-outan, the chimpanzee is more stocky, heavier, taller, and more powerful by far than the gibbon, and markedly less so than the gorilla. The maximum height of the male approximates five feet; of the female, four feet. Heck (1922, p. 648) cites Hartmann as his au-

thority for the figures: males, 1.7 meters; females, 1.3 meters. The weight of the sexes similarly differs: male, from 125 to

Fig. 71. Immature female chimpanzee, *Pan schweinfurthii*. Courtesy of Herbert Lang and American Museum of Natural History.

175 pounds; female from 100 to 150 pounds. Aschemeier (1921, p. 91) reports: "The largest adult chimpanzee I got measured four feet and weighed about 150 pounds."

Satisfactory physical measurements of the live adult chimpanzee are rare, but many authors report observations, and especially weight and height, of dead specimens and there are thousands of measurements for skins and skeletons. The reader will find additional information relative to size and also bibliographic lists in Keith (1896), Elliot (1913), Friedenthal (1914), Heck (1922), Sonntag (1924), Schultz (1927).

That the chimpanzee, and especially the male of the genus, is extraordinarily powerful is amply attested by the descriptive statements of those who as hunters, naturalists, or experimentalists have in various ways endeavored to capture or handle adult live specimens. The comments of such persons abundantly indicate that in proportion to size and weight, this ape is stronger than man, and the conclusion is supported by the following definite measurements. With a dynamometer, Bauman (1923, 1926) measured the strength, among other specimens, of a male weighing about 165 pounds and a female of about 135 pounds. His results indicated that the strength of the male exceeded that of the female by nearly 50 per cent and that the male was 4.4 and the female 3.6 times as strong as the physically well-conditioned and well-developed young man (1926, pp. 5-6). Discussing his results, the observer writes thus interestingly and with

Fig. 72. Female chimpanzee, *Pan chimpanse*, mature, estimated age twelve years. Courtesy New York Zoölogical Society, E. R. Sanborn, photographer.

suggestion of important psychophysiological problems:

First since chimpanzees are so much stronger weight for weight, and also muscle girth for

muscle girth, than men, to what factors do they owe this very striking superiority? Is the chimpanzee muscle of superior contractile quality square centimeter for square centimeter? Or is superior nervous stimulus exerted on the muscle fibres? Or is it partly one and partly the other? These questions are fraught with the greatest interest to the physiologist; a three or four to one difference certainly demands an explanation. No one could attribute it to exercise in comparing long captive chimpanzees with students fresh from strenuous farm labor. (Bauman, 1926, p. 7.)

As in the gorilla, the coat of the chimpanzee commonly consists of rather coarse, straight, black hairs, whereas by contrast that of the orang-outan is reddish, and that of the gibbon extremely variable. Color variations, whose significance and relations are imperfectly known, have been observed. Among them are brown, reddish brown, and grayish, as dominant colors, or as appearing in certain portions of the body. Almost certainly coat color and its variations are correlated with age, sex, species, nutritional and climatic conditions. Characteristic of many specimens, possibly also of species, are sparse short white hairs which, beard-like, appear on the lower part of the face, and a tuft of longer and more closely set white hairs in the anal region. Apparently texture, abundance, and length of the hairs vary more than does color. In some specimens, for example, the cheeks, sides of head, shoulders, and back bear exceptionally long hairs. The head may be thickly covered, with tendency to a middle part, or it may be almost bald. Adequate description of coat characters and their variations would require pages. No less surprising than interesting is the fact that several coat and skin characters have been utilized by taxonomists for purposes of classification and identification. This is well-nigh incredible when one recognizes the probability that many and perhaps all of the characters may readily and rapidly be modified by suitable control of environmental factors.

In conformity with density and distribution of pigment, the skin color ranges from an approximation to Caucasian "white" to dark brown or even nearly black, but never is it as black as in the gorilla. Often certain portions of the body, the face and hands,

Fig. 73. A vigorous mature but youthful male chimpanzee, with thick silvery coat. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

for example, exhibit freckle-like pigmented spots. In general, density of pigmentation appears to increase with age. In a chimpanzee type which is popularly known as the "white-face" the skin about the eyes is noticeably darker than that of the remainder of the face, whereas in the contrasted type designated as "black-face" instead of this facial contrast there is uniform darkness of skin. Keith (1896, p. 257), following reference to a score of titles on the coat and skin of the chimpanzee, remarks:

Pigment appears early in life in patches, which gradually fuse together, until all the skin becomes of a slate or melanoid tint. Remarks concerning the deposition and distribution of the pigment may be picked up from most of the writers cited above, especially from Du Chaillu; but very few of them seem to appreciate the fact that it is more a character of age than an indication of species. Its appearance at an early stage of life may turn out to be a character of only one variety.

We shall have cause to recur later, in the section on species and varieties, to the significance of coat and skin characters in the classification of chimpanzees.

Assuredly the configuration of the head

of the three manlike apes differs notably; yet when one attempts so to characterize it that the types shall be readily distinguishable the task proves to be discouragingly difficult. If we should here assemble the various phrases descriptive of the head of the chimpanzee which are to be found in morphological and classificatory works, it would immediately appear that many of them are mutually exclusive or contradictory. Seemingly it is relatively compressed, with either flattened or slightly concave crown. The transverse occipital ridge is slightly developed, as is also the sagittal crest which is so conspicuous in the old gorilla. But the supra-orbital ridges are initially conspicuous and become increasingly so with age.

The milk and permanent teeth of the chimpanzee correspond to the human in number and arrangement. "The upper premolar teeth, and indeed the whole dentition, of the Chimpanzee suggest however the human dentition much more distinctly than does that of any other Primate." (Duckworth, 1915, I, 248-249.)

Turning to facial characteristics, it is to be noted that the nose is relatively small, flat, with short bridge and depressed tip, and that it is set off from the remainder of the face by a pronounced groove or furrow. Because of the relatively prognathous jaws and the consequently conspicuous teeth, the covering lips are long and full. The upper lip is rendered especially conspicuous by the shortness of the nose. The distance from the base of nose to the edge of the lip may exceed an inch. Both lips are extremely mobile and protrusible, and they may be used separately or together and either in shovel or funnel form. The eye is frequently referred to as relatively large, brown in color, and expressive. Generally the ear is described as a conspicuous feature, because large and outstanding.

> Of the four anthropoids, the chimpanzee retains its ear in its most pristine and fully-developed form, having none of the marks of degeneration that characterise the ear of man, gorilla, orang, and gibbon. It varies very considerably with the individual, and on the sides of the same individual; but it is quite probable that it may turn out to be of value in assisting to characterise sub-species, although it can never be of value for absolute diagnosis. (Keith, 1896, p. 257.)

In the light of our observations the prevalent description of the ear is inadequate. The first specimen studied by us, a "black-face" from East Central Africa identified as *Pan schweinfurthi marungensis*, had small ears set close to the head, and in these respects more like those of the gorilla than of the typical West African chimpanzee (Yerkes and Learned, 1925, p. 20). It is just such extraordinary variations as this which discourage attempts to give a generally applicable and usefully detailed description of the external characters of the species of chimpanzee.

Ordinarily, then, by its coat color the chimpanzee may be distinguished from the orang-outan, and by its nose and ears from the gorilla, for in the latter the typical proportions are reversed—a conspicuous long-bridged nose and relatively inconspicuous ears.

The chimpanzee is short of neck, and although it possesses laryngeal sacs, as do all of the anthropoid apes except Hylobates, they are never conspicuously inflated as may be the case in siamang and orang-outan. (See Keith, 1896, p. 255, and Sonntag, 1924, p. 261.)

One frequently meets the statement that the legs of the chimpanzee are longer than those of the orang-outan and the arms shorter, and also that the limbs are more nearly equal than in any other anthropoid ape. Exception is taken, however, to both of these statements, and it is certain that individual or species variations invalidate them. The forearm is said commonly to be longer than the arm, and the hand than the foot. Although the arm sometimes reaches only to the knee, it frequently is much longer. The fingers, although commonly long and slender, with very short and diminutive thumb, may instead be stubby. Likewise, the foot is long, but whereas in some specimens, or perhaps species, it is

also narrow, in others it is relatively broad. In any case the great toe is large, strong, and opposable. Fingers and toes, with the

Fig. 74. Male chimpanzee, *Pan chimpanse,* estimated age ten years. Courtesy New York Zoölogical Society, E. R. Sanborn, photographer.

exception of pollex and hallux, are usually connected by web, but the degree of connection varies extremely. Normally, each digit terminates in an oval brown to black nail.

Perhaps as a concise summary of the points which have been made, and as suggestion of certain others which the taxonomist finds serviceable, Elliot's paragraph characterization of the genus Pan, or chimpanzee, may be useful to the reader:

> Body rather stout, heavy; legs long, foot shorter than the hand, the great toe thick, opposable; the other toes united by a web; arms long, reaching just below the knee; hands, broad, short; thumb short, four fingers united by a web; middle finger the longest; nose depressed in middle, flat at end; nostrils opening downward; lips mobile, protrusive; ear large. Skull elongate; no central crest; supraorbital ridges large; jaws protrude forward; canines long, conical, small diastema between them and premolar; anterior lower premolar pointed; molar teeth with four cusps except middle lower molar which has five. Humerus nearly equal in length to the radius. (Elliot, 1913, III, 227.)

Inasmuch as for morphological account of this ape, aside from general configurational characterization, the reader is expected to consult the special literature, it is appropriate as conclusion of this section to offer a few particularly important references: 1, Tyson (1699); 2, Martin (1841); 3, Hartmann (1885); 4, Vrolik (1841); 5, Gratiolet and Alix (1866); 6, Sperino (1897); 7, Sonntag (1923); 8, Keith (1896); 9, Sonntag (1924). Of these the first is historically important; the second and third give excellent, although old, morphological descriptions of the chimpanzee; the next four are examples of detailed and inclusive anatomical studies, and the eighth and ninth titles are especially valuable for their summaries and bibliographies.

SPECIES AND VARIETIES

In our Chapter Five, "Terms, Types, Relations," classifications of the primates are presented and the subdivisions of the genus chimpanzee, as accepted by Elliot, enumerated. It is proposed in this section to supplement the previous discussion by presenting the contrasted views of three authorities and by exhibiting the nature and grounds of uncertainty concerning species of chimpanzee.

As puzzling almost as the diversity of man is that of the chimpanzee. Taxonomic opinions, arguments, and descriptions differ radically. As we are not prepared to defend a particular system or position with respect to principles of classification, we shall permit those who presumably typify varying points of view to speak for themselves.

The anatomist Sonntag, although not a systematist, somewhat dogmatically holds to a position of extreme simplicity, as the following quotation indicates:

> As the external characters of the Chimpanzee exhibit considerable variation with age, sex and locality, it is not surprising to discover, on con-

sulting the literature dealing with taxonomy, that zoologists have invented specific names for mere varieties. And Trouessart [reference not given] has collected the various synonyms which have been applied to the two real species—the Common Chimpanzee (*Anthropopithecus troglodytes*) and the Bald-headed Chimpanzee (*A. calvus*). (Sonntag, 1924, p. 91.)

This author's manner of expression would seem to indicate impatience with conflicting opinions, confusion, and complexity in classification. His position may readily be attacked on the basis of such facts and opinions as appear in the following paragraphs.

Typical of extremists in the multiplication of species is Matschie (1914, 1919), who recognizes no less than fourteen distinct species. Disagreeing profoundly with Sonntag, and also with Elliot (1913), this taxonomist thus vigorously defends the stability of species.

By one who has long worked comparatively in a large collection of mammals, these questions can only be answered in the negative. He finds among mammals no transition between different species; he recognizes that each small community embracing a larger number of blood-related kin, whether one designates them as species, subspecies or races, according to special conceptions, possesses fixed, unchangeable characteristics. In all cases where a mammal unites the characteristics of two forms in one . . . careful investigation will prove that it is a hybrid. Such hybrids occur only where the regions of distribution of two species touch; but they never make new races. One seeks in vain for proof of the origin of one species of mammal from another.

The species most like one another, whether one regard them as sub-species of the same species, or species of one and the same sub-genus, inhabit separate regions, so that each lives alone in that part of the earth taken possession of by that species or sub-genus. (Matschie, 1919, p. 62.)

The conclusions expressed by Matschie in his contribution of 1919, in which he distinguishes fourteen species of chimpanzee and endeavors to establish their geographical isolation, are based partially at least on comparative study of 182 skulls and 119 skins in the Zoölogical Museum of Berlin, and of 140 skulls and 40 skins in other collections (Matschie, 1919, p. 63).

As we have endeavored thus briefly to indicate general basis for criticism of Sonntag's position by describing that of Matschie, so we now shall exhibit what may prove to be weaknesses in the arguments and observations of the latter by quoting an authority who doubtless would disagree as radically with the one as with the other. The author of the extensive *Review of the Primates*, Elliot, prefaces his description of species and qualifies his conclusions thus:

It cannot be said that at the present time, a list of the species and races of Chimpanzees can be satisfactorily given. We really know so little about them; the color of the young, the changes that take place from youth to age, the hues of the face, hands, and feet, whether these are permanent from youth to the adult state, what, if any, are the distinctions in color between the sexes, (in some species we know there is no difference, but in others we are not so sure); what are the limits of the dispersion of those we gaily describe as distinct—do two or more species or races, call them what you will, dwell together in amity retaining their distinctive characteristics within limited areas; all these problems and more arise to greet us, and for the most of them we have no answer.

The material gathered in most Museums is so small and unsatisfactory, that it is of no avail in deciding the facts we all seek. The best, and so far as I have found, the only considerable collection of these animals extant to-day, is in the Berlin Museum, where about eighty skins and perhaps as many skulls have been brought together from different parts of Africa. But when we study these, we constantly meet with difficulties that not only perplex us, but prevent any satisfactory decision from being reached. It is easy enough to solve a difficulty by describing some troublesome specimens as new, and leaving the proof for some one else to discover, but that does not solve legitimate doubts, nor help overmuch to teach us the truth we desire to know.

In seeking for characters upon which specific differences may be founded we naturally first examine the crania, and at once we are confronted with a fact that prevails among all the great Apes, that individual variations exist to such an extent, that no one character can be depended upon, for no two skulls are alike, and they differ from each other in a manner equally great as is observed among human skulls. . . . At present, therefore, we rely mainly for our specific characters of these animals upon the texture, length and color of the hair; the presence or absence of beard; color of the face; sometimes of the hands and feet; seldom on the teeth, (for characters among these are rarely found), the extent in

which the face is prognathous, and the presence or absence of a part in the hair on the head, or the existence of baldness, and its extent behind the ears. No doubt some of these are valid specific characters, and it is equally certain that there are several species of Chimpanzees, but it may also be regarded as a fact, that some of the characters above cited as specific are not valid, and that, with the material at present available no one can decide how many of the specimens described have an undoubted specific standing. That problem will be solved by our successors; at present we are groping in the dark so far as the number of existing species of the great Anthropoids are concerned. (Elliot, 1913, III, 227-229.)

Since Elliot freely admits the variability of characters of coat and skin, and the extreme uncertainty of specific value, it strikes one as odd that he nevertheless should use color and length of hair as primary categories in his key to the species and subspecies of chimpanzee. Of the three principal categories employed, the first is entitled "pelage all black"; the second, "pelage not all black"; and the third, "pelage mostly brown in adults." (Elliot, 1913, III, 234.)

Obviously enough, Elliot's is a conservative position, intermediate between the extreme stands taken by Sonntag and Matschie. Unfortunately we are not in position to decide which, if any, of these authorities approximates the truth. The lesson, however, is clear that information at once more reliable, more definite, and more ample is requisite for satisfactory description and classification of chimpanzees. Our reflections direct themselves toward a possible way out of the difficulty.

This is the situation confronting us. Extreme uncertainty about the existence and differentiae of species, together with lack of definite knowledge about the limits and relations of variations, render it practically impossible to offer useful accounts of the configuration of either the sexes or species in various developmental stages. It is well established for the chimpanzee, as in man, that many characters change profoundly with growth and maturation, so that in the adult or senile individual there may be little suggestive of the configurations characteristic of infancy, childhood, or adolescence. Those who endeavor to utilize the best available descriptive materials are baffled constantly by the virtual impossibility of deciding whether a given character or condition thereof is distinctive of individual, sex, or species. Clearly enough, this unprofitable situation indicates the necessity for a unique procedure; namely, the establishment of breeding areas or stations in which the chimpanzee may reproduce and be systematically observed under controlled conditions. Well-chosen and accurate physical measurements on ten specimens of known ancestry, age, and life history for each so-called species, for each sex, and for several stages in growth and development, should be worth more as contribution to the chief problems of classification, development, and variation, than are the hundreds of skulls, skins, and skeletons which constitute the miscellaneous and inadequately describable collections of the world's great museums. Wasteful indeed, and futile, by comparison with the suggested procedure, is the prevalent method of collecting specimens for measurement.

One point made by Elliot demands critical comment. He remarks that cranial characters are valueless as differentiae of species because "no two skulls are alike." Surely it could not have escaped his attention that variation is inevitable and that the forms of distribution, as for example, segregational, or otherwise, indicating definite and relatively stable types, are the significant facts for taxonomy.

After the first three parts of this volume had been written there appeared in 1927, under the title *The Nomenclature for Man, the Chimpanzee, the Orang-utan, and the Barbary Ape,* a historical review by Stiles and Orleman of the terms which have been applied to these primates. Had the discussion become available a year earlier it would have saved us much labor in the preparation of our historical chapters. It is an invaluable compilation and an illuminating discussion of defects of nomencla-

ture and of the requirements which must be met for escape from the present confusion. The conclusions of these authors are important and pertinent: Under the International Rules the following are the earliest available, and therefore valid, generic and specific names for the chimpanzee: as generic name, *Simia* Linn., and as specific name, *satyrus* Linn. (Stiles and Orleman, 1927, p. 59.)

What can be done under present circumstances, ask Stiles and Orleman, to escape confusion and misunderstanding? Their reply is: Accept the law of priority and utilize for the type chimpanzee the Linnaean term Simia.

It seems that at various times during the last two centuries this anthropoid ape has been known as: Simia, Chimpansee, Anthropopithecus, Hylanthropus, Chimpanza, Pseudanthropos, Engeco, Tschego, Pseudanthropus, Pan, Troglodytes, Mimetes, Theranthropus, Pongo, Palaeopithecus, Satyrus! (Stiles and Orleman, 1927, p. 52.)

Small wonder that confusion exists. Of the authorities especially quoted in this section, Sonntag and Matschie adopt Anthropopithecus as their generic term, Elliot uses Pan, and Stiles and Orleman, on the basis of priority, strongly recommend Simia, as does also Rothschild (1904) in describing five species. For the psychobiologist, as we previously suggested, page 42, there appears to be a simple escape from this taxonomic tangle, for he may with certainty of being understood designate the type of ape as chimpanzee, adding such specific term as indications of stable differentiating characters and the rules of priority dictate.

DISTRIBUTION, FREQUENCY, AND HABITAT

Most widely distributed of all of the anthropoid apes, the chimpanzee is found over an extensive area in West and Central Equatorial Africa. The so-called common type, perhaps predominantly white-faced and comprehending an indefinite number of species, is found, widely distributed, in West and West Central Africa. Whereas, by contrast, the bald-headed or black-faced type, according to present information, occurs only in Central and East Central Africa.

The recognized range of the genus has been steadily extended during the last century, partly by the discovery of the Central and East Central variants, but also by reports of West African forms from new regions. Keith, after noting observation of specimens in specific localities, remarks:

> In fact, its distribution may roughly be said to be the areas drained by the Congo and Niger, and it also occurs along the banks of the smaller rivers on the west coast as far north as lat. 16°, and as far south as lat. 14°. (Keith, 1896, p. 258.)

Perhaps at once the most concise and generally useful account of distribution for the psychobiologist is that offered by Elliot. But his information is subject to confirmation and correction in the light of more recent findings.

> It cannot be said that, at the present time, we know the limits of the range of any of the recognized species of Chimpanzee. Several of them are known to inhabit the same districts of the West African coasts, but exactly how they may be distributed in the localities they frequent has not been ascertained. Gaboon is supposed to contain five species, or species and races as different writers may regard them, and Cameroon has four, with possibly three more not yet described. Of these so far as known there are only two of the recognized species which do not inhabit both Cameroon and Gaboon, viz.: *P. satyrus* not found in Cameroon and *P. vellerosus* not met with in Gaboon, leaving three found in both districts, and three as yet unrecognized specimens in the Berlin Museum, restricted, as supposed, to certain districts in Cameroon. If our determinations are correct, we have the singular fact that nearly all the recognized forms of Chimpanzees, like the Gorillas, are crowded together on a small portion of West Africa, leaving us to wonder how so many distinct forms, if they are such, could exist in so restricted a territory and preserve their specific characters intact.
>
> Commencing on the West African coast at the most northern point where these Apes are known to dwell, we have *P. chimpanse* from Gambia, and *P. leucoprymnus*, said to have come origi-

nally from Guinea, but supposed to range from Sierra Leone to Liberia, but this distribution cannot be said to be satisfactorily authenticated. *P. fuscus* is stated to have come from the Gold Coast, but as there is no specimen of this form in any collection, its habitat is at best but obscure. In Cameroon is *P. vellerosus* not as yet found elsewhere, and ranging from Cameroon into Gaboon are *P. calvus, P. aubryi* and *P. kooloo-kamba. P. satyrus* is apparently restricted to Gaboon, while *P. fuliginosus* ranges from Gaboon into French Congo, but its limits are not known. From Basho, Dunne and Lomie, interior of Cameroon, are specimens in the Berlin Museum which appear to differ from the recognized forms. In East Africa, in the Niam-niam country, and from Albert Nyanza to Tanganyika on the west, going into the Congo forest but limits unknown are *P. schweinfurthi* and *P. s. marungensis.* (Elliot, 1913, III, 233-234.)

Writing from intimate personal acquaintance with Africa and its fauna, Sir Harry Johnston, in his introduction to Barns's *Wonderland of the Eastern Congo,* in certain directions importantly supplements the information supplied by Elliot.

The chimpanzis in several species or sub-species are found in the southern part of the Bahr-al-ghazal province of the Anglo-Egyptian Sudan, and thence southward (through Unyoro and Western Uganda) along the western side of Tanganyika to the district of Marungu and possibly the vicinity of Lake Mweru in S. lat. 8°. Certainly the gorilla and apparently the chimpanzi, are not found *west* or *south* of the main stream of the Congo; the chimpanzi, however, is fairly abundant through the northern forested Congo basin to the Luango coast and the Cameroons. Chimpanzis are found in the eastern and perhaps the western parts of Southern Nigeria. They have never been reported from Dahomé, and their existence in the Gold Coast is not established. But they are still found in the Ivory Coast forests, in Liberia, Sierra Leone, and much of Senegambia up to the Gambia River. They are larger and superficially more gorilla-like in the eastern half of their range than they are in West Africa.

It would almost seem at one time as though their range in the Eastern Sudan brought them within the cognizance of the ancient Egyptians, for chimpanzis were certainly known to the Greeks in the Greek colonies of Mediterranean Egypt, whither they may have been brought as curiosities from the Sudan. In the Tanagra collection of the British Museum may be seen several models of anthropoid apes, about five hundred to six hundred B.C. in approximate date, which can only have been derived from a study of the chimpanzi. One of these—an ape riding an ox—is such a remarkable reproduction of the Schweinfurth chimpanzi that I cannot think it can have had any other model. I imagine that this ape must have been occasionally imported into Egypt from possibly a farther north habitat than it at present possesses. (Johnston, in Barns, 1922, pp. xxvi-xxvii.)

Matschie asserts that proof is lacking that any two species inhabit the same area, although occurrence in contiguous areas is well authenticated. The occurrence of the species "kooloo-kamba" and "aubryi" in the Cameroons this author denies (Matschie, 1919, p. 77). It is difficult to see how species distribution can be definitely determined in the present unsatisfactory status of classification.

Definite information concerning frequency or abundance of the chimpanzee is lacking, but the statements of natives, travelers, collectors, hunters, and naturalists, commonly imply their abundance in certain regions. Typical of such information is the statement of Pechuël-Loesche:

In some regions, especially in Kuilu from Mamanya ma tali outwards to Bumina and at the mouth of the Banya, they must be extraordinarily numerous to judge from the noise audible on all sides. (1882, p. 246.)

Although basis for numerical estimates is lacking, it is entirely clear that chimpanzees are far more abundant, as well as more varied, specifically or otherwise, than gorillas. The Kindia Laboratory of the Pasteur Institute in French Guinea is reported to have received in the year 1925 eighty-nine living specimens of chimpanzee, of which fifty per cent died within two weeks of arrival (Honoré, 1927, p. 408). So large a supply of animals, which are difficult to capture alive, reported by a single institution, the considerable number of living specimens received annually in Europe and the United States, and also the ease with which collectors for museums and other institutions satisfy their needs, indicate that there is no dearth of chimpanzees.

The forests of Equatorial Africa consti-

tute the habitat of the chimpanzee, and although the animals frequent water-courses, they travel over hill and dale in accordance with seasonal conditions and available food supply. Although markedly arboreal in habit and unsuited for life on the open plain, they nevertheless spend much of their time on the ground. The reader will find further details concerning the characteristics of habitat in such taxonomic works on the primates as Forbes (1894) and Elliot (1913); in natural histories, for example, Cambridge Natural History (1902), Harmsworth's (1910), Brehm (1922), and in such special contributions as those of Sokolowsky (1908), Adolf Friedrich, Duke of Mecklenburg (1909), von Oertzen (1913).

CHAPTER EIGHTEEN

MANNER OF LIFE, LOCOMOTION, NESTING, AND CAPTURE OF CHIMPANZEE

A FEW years ago this section naturally would have been entitled "instinct and habit." Today we hesitate to use the terms because the concept of instinct is in process of redefinition, and observation tends steadily to limit its application, while extending that of habit. No longer are we willing to label an act instinctive simply because we lack evidence of its acquisition or modification by the individual organism. Freely admitting our ignorance, we refrain from *a priori* classification of activities as instinctive or habitual, and in general suspect that a given pattern of behavior will be found to exhibit both structurally given and individually acquired aspects.

In the pages which follow we would describe, in the light of naturalistic and experimental observation of both free and captive animals, the behavioral traits of the genus and of the typical individual chimpanzee. A useful picture of the status of knowledge of this great ape a century ago is given by Rennie, whom once more we quote:

> The great interest attached to the chimpanzee, as approaching so nearly to ourselves in the scale of animal life, has induced us to dwell longer upon this part of his history than we had originally intended, but we hope without either wearying the patience or exhausting the curiosity of our readers. A thorough acquaintance with the manners and intelligence of the young animal, as accurately observed and related by zoologists accustomed to such investigations, was besides necessary to enable us to form a just estimate of the habits and economy attributed to the adult in his native forests, and of the degree of credit to which the accounts of different travellers are entitled. On this part of the subject, however, we have to regret the scanty and imperfect nature of our information; we have, comparatively speaking, few accurate details relating to the natural habits of the adult chimpanzee: and this defect is the more to be lamented, as the character of their intellectual powers displayed in the young specimens whose history we have related, affords strong grounds for believing that the manners and economy of these animals would offer many curious points of resemblance with savage life, and perhaps afford some valuable data for illustrating the probable condition of man previous to the origin of civilised society. We are told, indeed, that in a state of nature, the wild chimpanzees erect rude huts by intertwining the branches and leaves of trees; that their stature approaches that of man; that they walk upright, arm themselves with clubs, live in a kind of rude society, unite to expel beasts of prey and other large animals from the cantonments which they occupy, attack and beat the negroes whom they find alone in the woods, and occasionally kidnap the young negresses, whom they carry with them to the deepest recesses of the forests, and subject to the most frightful and revolting captivity; but their domestic economy, the nature of the union or intercourse which subsists between the sexes, the bonds by which they are united in society, their passions, appetites, customs, and a thousand other inquiries of equal interest, have been totally neglected: nor is it probable, in the present state of African society, that we shall have much light thrown upon these subjects, at least for some time to come. (Rennie, 1838, pp. 71-73.)

The status of knowledge has not changed as much nor as favorably since the time of Rennie as we might naturally expect and desire. Indeed, an adequate description of the free wild life of the chimpanzee has not been written. Even now it is a difficult task which we reluctantly undertake. Particular examination of the chief aspects of the daily life of this great ape, and of its relations to its natural environment, we shall preface with a highly generalized verbal picture.

In the upland and lowland jungles and the watercourse forests of Equatorial Africa one finds the animal at home. Keen of sight and hearing, alert, quick of movement and adaptable, it climbs nimbly and skilfully. Yet it is not less terrestrial than arboreal,

for some individuals, and probably certain species, spend much of their time on the ground. Although markedly less arboreal in habit than the gibbon and orang-outan, it is considerably more so than the gorilla. Tall trees are its natural haven and resting place. In them it finds refuge from enemies and natural lodgment for its bed. The construction of nest-like sleeping places is not universal, and it appears to be limited to certain species. In climbing, as well as in grasping, hauling, pulling, or otherwise manipulating objects, this ape uses its hands and feet almost interchangeably. Although it can readily stand and even walk erect for a time, it usually, and by preference, walks on its four extremities. The feet may rest flat on the ground or on the inbent toes, but the hands invariably are partially closed so that the weight rests upon the knuckles and backs of the fingers.

By preference and habit this ape is a vegetarian whose nutriment is abundantly supplied by the plants of its habitat. Probably there are individual and species differences in diet, for the literature contains many reports of the use of animal foods. Nevertheless, a strictly carnivorous specimen or species has not been found.

Except for isolated old males, and the temporary isolation or segregation of other individuals, the chimpanzee is highly social and always lives in bands which are constituted either by a single family or associated families. By contrast with the orang-outan, this extraordinarily interesting anthropoid ape is active and full of initiative. The contrast extends even to vocalization, for the tropical forests are said to resound, often at night as during the day, with the cries and tree- or ground-drumming of the chimpanzee.

In endeavoring to characterize the animal behaviorally, or to describe more explicitly particular traits, we must beware of two omnipresent sources of error and misapprehension. They are relations of behavior to environmental conditions, as, for example, in free wild life or in captivity, and to species, variety, sex, age, or individuality. It is chiefly because of the significance of such relations and variations that our description of mode of life must be so highly generalized that it at first sight seems almost valueless. The obvious lesson from these facts, and it is one early learned by the conscientious observer, is that descriptions of behavior must indicate environmental situation and the nature and status of the subject. Throughout this work we have endeavored to avoid confusion of behavior which appears under different conditions or in different species, developmental conditions, or individuals. Obviously enough there is need of full and reliable knowledge of the normal behavior of an animal in its natural habitat, and, by contrast, of its more or less radically modified activities in certain highly important conditions of captivity. It would be difficult to believe that the chimpanzee in a psychobiological laboratory, a zoölogical park, or a circus, would behave precisely as in nature. It is equally certain that species differences may not safely be ignored.

The information available to us from the literature and from our own observations is wholly inadequate to satisfactory description either of the free wild life of the chimpanzee, or of differences or variations due to captivity, species, or individuality. Nevertheless, a considerable store of information is available, and it is our task to present it, as accurately and completely as may be, in order that both its values and its defects may assist investigators in extending and perfecting knowledge.

Although there is no single first-rate source of assembled information about the natural free life of the animal, the following references are useful as indicating either particularly important assemblages of observations or original contributions. We present them in chronological order so that the reader may obtain historical perspective as well as the natural sequence of discovery. Temminck (1835-41), Rennie (1838), Martin (1841), Savage and Wyman (1843-44), Du Chaillu (1861), Huxley (1863), von Koppenfels (1877), Hartmann (1885),

Fig. 75. Characteristic postures and attitudes of adult and young chimpanzee. From Brehm's *Tierleben,* 1922, p. 623, Bibliographisches Institut.

Forbes (1894), von Oertzen (1913), Reichenow (1920), Aschemeier (1921, 1922), Heck (1922), Brehm (1922), Buck (1927).

References to authorities who have serviceably described specific aspects of the chimpanzee's mode of life may appropriately be reserved for later paragraphs. But it is in point to suggest at least a few of the more important general descriptions of those variations in behavior which may perhaps safely be attributed to species, status of development, or individuality. Again only a few references are especially in point. We should repeat those listed above, with particular emphasis on the usefulness of the contributions of Rennie, Martin, and Heck, and should add primarily as specific studies of individual captive specimens: Schmidt (1878), Kohts (1921, 1923, 1928), Kearton (1925), Köhler (1925), Yerkes (1925), Yerkes and Learned (1925), Bingham (1928).

Of species differences in behavior relatively little is known because behavioral descriptions are so seldom accompanied by species identification. It is, however, convincingly indicated by various naturalistic observers, and especially by taxonomists, that structural and distributional differences, upon which classification primarily rests, are correlated with correspondingly interesting and significant behavioral traits and peculiarities in mode of life. We cite as an illustration the phenomenon of nest construction. On this subject the literature is self-contradictory. Even the same observer may state at one time that the animal does not build nests, and again that it does. In view of the total body of information available, it appears most probable that such contradictions or discrepancies are due to specific differences in behavior. One may not attempt behavioral characterization of species, for available data are entirely too meager and inaccurate. But when in subsequent paragraphs we consider particular aspects of mode of life, we shall endeavor to present evidences of variations which may be specific.

Naturally, intimate acquaintance with individuals is strictly limited to captive specimens. Nevertheless, for understanding of the results of field observations as well as of experimental studies, such definite pictures of the behavioral constitution of individuals as may be got from a few authorities are invaluable. Because of the present lack of norms or other standards of judgment for chimpanzee behavior, it is virtually impossible to select typical specimens. The observations of psychobiologists definitely indicate that individual variations are extreme and, as in man, range from forms of mental deficiency, or more commonly in specimens which have been intensively studied, moronity, to such extraordinary degrees of ability as would ordinarily be designated as superiority or genius.

Neglecting the historically important descriptions of specimens to which in various connections reference has already been made, we will acquaint the reader with an individual chimpanzee by borrowing the description of Nadie Ladygin-Kohts.

Basing her word picture primarily on intimate acquaintance over several years with an experimental subject called Ioni, she says:

> The chief characteristics of the chimpanzee are his desire for locomotion, his need of play, and of social intercourse. Fear is his constant companion. He is panic-stricken and avoids everything that in any way threatens his physical welfare, and, cowardly, retires before an actual danger. Although in case of forced competition he may become violently and destructively angry. The struggle is especially fierce for the possession of property, for liberty, and in defense against attack. He has an inclination for affection, but himself does not show too much inclination for caress. His egotism often borders on despotism and tyranny when he finds no opposition, as for example in the case of children who are smaller and weaker than himself. In such instances his animal instincts are fully unleashed. Of the positive qualities of the chimpanzee the first to be mentioned is his constant activity. Great curiosity is the chief impulse. There is fine power of observation and imitation, but the difficulty in experimenting lies in psychic instability, as expressed in lack of patience in overcoming difficulties, in getting tired quickly, and in the search for new impressions. (Free and condensed translation from Kohts, 1921.)

Despite its incompleteness, this picture brings one close to the life of its subject. It is impossible to say whether Ioni was a typical specimen, or instead somewhat below or above average.

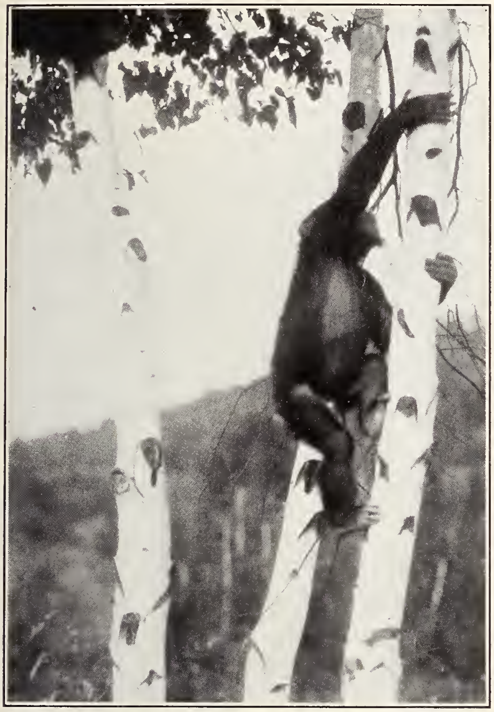


Fig. 76. Young male chimpanzee climbing a birch tree. Scene Yerkes farm, Franklin, New Hampshire.

LOCOMOTION

It now is in order to describe more particularly, and with citation of authorities, the characteristic features of chimpanzee activity. First in conspicuousness come locomotion and related uses of the extremities. Description should include arboreal and terrestrial behavior, agility, dexterity, handedness, rhythmic and other specialized forms of natural movement of hands and feet. As usual, there are informational fragments from many sources, but nowhere completeness of description. Extreme variation and diversity of behavior are abundantly indicated. The early descriptions, many of which have been referred to and quoted from in our historical chapters, are based either on observation of captive specimens or on inadequate and usually uncertain reports of the modes of locomotion in nature.

Aside from characteristics which are specific, it is well established that during the life history of the individual profound changes in mode of locomotion, agility, and dexterity occur. Sonntag, among others, in briefly commenting on the "habits" of the chimpanzee, particularly mentions age-changes.

> Those who have studied Chimpanzees in their native haunts describe them as active, agile creatures. They run about on the ground in a quadrupedal manner, using their fore and hind limbs almost equally. They also jump off one foot which is used like a spring-board. In the trees they swing about as actively as some Gibbons. When the animal has been in captivity for a long time it develops stiffness of the joints, and its active movements are replaced by an awkward gait in which the body is dragged along, the forearms being used like crutches. It must be emphasized, therefore, that the mode of locomotion of an old menagerie specimen is quite unnatural. (Sonntag, 1924, pp. 88-89.)

It is a matter of common observation also that in captivity the animals develop locomotor and other mannerisms or transient habits, sometimes seriously, sometimes playfully used, which are undoubtedly in part

Fig. 77. Adolescent female chimpanzee in birch tree at Franklin, New Hampshire.

imitative, but as often responses to their environment. These, like the relative slothfulness of maturity and the inactivity of senility, may mislead the inexperienced observer or reader. We shall endeavor to avoid misinterpretation, unnaturalness, or confusion, by basing description primarily on observation of free wild specimens.

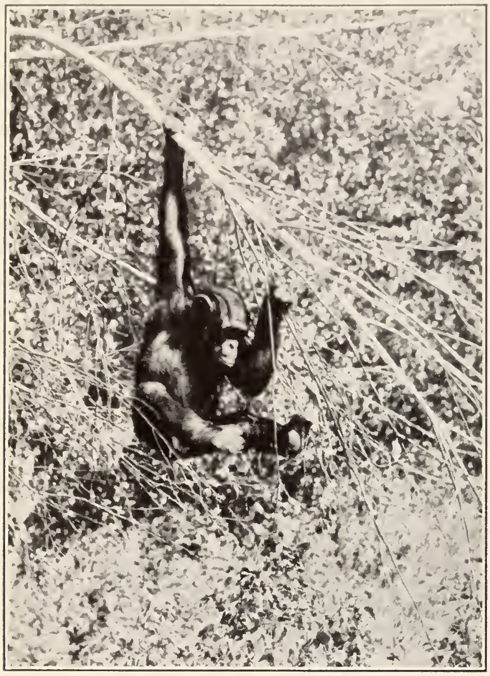


Fig. 78. Childhood. A five-year-old male chimpanzee playing in a New Hampshire pasture.

The chimpanzee is rightly described as eminently arboreal, for it is capable of climbing surely, skilfully, and in varying ways. Of its methods, by contrast with those of the monkey, Jones (1916, pp. 112-113) says:

> The Chimpanzee adopts the same methods of climbing [hanging by the arms with the feet free or walking in semi-erect posture with both hands and feet in use], methods which involve a semi-erect foot balance combined with a dependence upon a powerful hand grasp. More rapid translation from branch to branch, or from tree to tree, is not performed by a spring from the resting feet, but by a swing from the grasping hands. A group of monkeys passing from tree to tree in the jungle will jump those gaps where branches fail to meet, but a party of Gibbons will swing themselves across the gap, releasing one hand-grasp only to gain another. It is in this fashion that human performers on the high trapeze pass from one swinging bar to another.

That the animal is thoroughly at home in trees, and that such statements as have been quoted from Sonntag and Jones are observationally well established, is evident from such reported observations as those of Savage and Wyman (1843-44), Christy (1915), Reichenow (1920). Various observations, in addition to his own, are cited also by Heck (1922).

Occasionally it is said that the chimpanzee almost flies through the air. By comparison with the corresponding mode of locomotion in the gibbon and in certain monkeys, the phrase is inappropriate, for although both young and mature chimpanzees can swing themselves rapidly from branch to branch and may on occasion as it were throw themselves or fall through the air from one handhold to another, they fall far short of the approach to flight which is natural to the gibbon.

It appears to be well established, then, that the chimpanzee is in varying degrees arboreal, that it ordinarily climbs with facility, is capable of grasping and clinging to trees with hands or feet, or both, that it may swing itself from branch to branch, but

Fig. 79. A pair of youthful chimpanzees climbing and swinging in the birches.

seldom if ever jumps by propulsion with legs as do many monkeys. Agility, which is relatively high during early life, diminishes with maturity, and in old age arboreal habit may disappear in favor of an exclusively terrestrial life. So numerous and varied are the accounts of arborealness in captive specimens, and so obvious the significance of nutritional and other factors of captivity, that we refrain from special citation.

Equally well established with arboreal adaptation and habit are the terrestrial. In the frequency of appearance or dominance of one or other mode of existence, species differences may exist, but they are not clearly established by the information at our command. Capable of standing and walking erect for short times and distances, this attitude and mode of locomotion is relatively difficult for the chimpanzee and it generally walks on hands and feet, usually with the hand half clenched, so that the weight rests on the knuckles and dorsal surface of the middle and end phalanges. The feet may rest flatly on the ground or the toes may be bent in so that they support a part of the weight. Walking also presents many variations, for especially in young animals it may be by measured tread and bear-like, or by running in a canter gait, or even in an amusing likeness to the gait occasionally seen in the dog, in which the body, instead of being directed straightforward, progresses at an acute angle, the hinder portion as it were tending to overtake the fore part. Frequently observed also is use of the arms crutch fashion, so that the body is swung forward with weight wholly on the arms until the legs are well forward between them.

The natural posture of the chimpanzee has commanded attention because of its possible evolutional significance, and Osborn (1915, p. 58), for example, cites the erect attitude, the opposable thumb, the growth of the brain, and the acquisition of power of speech, as possibly significant evolutional trends. Referring particularly to the resting posture, Keith (1923a, p. 453) points out that the chimpanzee lacks ischial callosities and is unable to rest completely sitting semi-erect as do many monkeys, but must instead lie prone as does man.

Although there are assertions which appear contradictory to the fact, it is we believe safely established that the normal adolescent or mature chimpanzee can climb with speed as well as agility and can run on the earth for a considerable distance even faster than the average man. Whereas jumping by leg propulsion when on a tree is an exceptional occurrence, according to consensus of opinion, similar jumping on the ground is commonly observed. Here our own experience notes striking contrast between the young chimpanzee and the mountain gorilla of like age, for the former jumps willingly and efficiently with adequate motivation, whereas the latter does not.

Among the authorities from whom we have drawn either first-hand or secondary information, we note the following: Rennie (1838), Savage and Wyman (1843-44), Nissle (1872), Pechuël-Loesche (1882), Hartmann (1885), Forbes (1894), Klaatsch (1913), Lankester (1922), Heck (1922), Keith (1923a).

We would conclude this description of terrestrial activity by peculiarly appropriate quotation from Köhler, whose report, as it happens, we are able to verify from our own experience with more than a score of captive chimpanzees.

> Sultan, who was also much above the average in intelligence, performed extraordinary antics with his own limbs and body, during his spell of isolation. Often, as he squatted on the ground, he would take hold of one of his own legs with both arms, stroke it, rock it to and fro, and generally treat it as some pleasant, but wholly exterior, object. Or he would stretch out either one or both legs on the ground, limp and motionless, and shuffle along on his powerful hands.[1]—There are several such "fancy" methods of locomotion among chimpanzees. In their usual walk, the hand is placed on the ground in such a way as to touch it only with the fingers, which are bent inwards. Suddenly however, in play, one of them will

[1] "This was not the trivial variant of the chimpanzee's mode of locomotion, in which the hands support the body, and the flexed lower limbs are swung forwards between the arms."

crouch forward, touching the earth with the whole palm, and remain in that posture for a while. Upright walking forwards (without brachial support) takes place when the hands are full, when the ground is wet and cold, or when the animals are excited in various ways. But in special individual chimpanzees, whose peculiar build is well adapted to the upright posture, it may become a "fashion," a form of play that persists for days. I recollect seeing somersaults turned by both orangs and chimpanzees. Chimpanzees also sometimes lie down at full length on the ground, and revolve with vertiginous speed, round their own length, to a distance of many metres. When in so doing they wrap themselves in a blanket, or creep into a sack beforehand, the impression they produce is comic in the extreme, and their fellow-apes play all sorts of pranks with the rolling bundle. When they play in groups of two, three, or more, these games assume still more different forms; one will lie limp and motionless, a friend seize his arm or foot and drag him along like a corpse or inanimate mass. Or a little ape will leap onto the shoulders of a larger one, and make him carry him, and then slide gradually forwards to his neck, drop on his hands, and march solemnly along with him like a new six-legged monstrosity. (Köhler, 1925, pp. 324-326.)

SWIMMING

We have discovered no definite statements as to the swimming ability of the chimpanzee or its natural attitude toward water. Certain authorities infer from distributional observations that the crossing of rivers or other large bodies of water is at best exceptional, and the evidences appear reasonably convincing that bodies of water are mistrusted or dreaded by the animals and perhaps generally avoided, except for drinking or playful washing. Although the behavior of captive specimens is not satisfactory basis for inference concerning the natural attitude toward water, it is our sole informational resource. There is, according to our own observations, marked difference in degree of interest in water as a play medium. Of four animals which for many months have been under continuous observation in the Yale Primate Laboratory, one, a male, eagerly avails himself of every opportunity to play in a bucket or tub of water. The others, if they do not entirely ignore such opportunity, seem to obtain less satisfaction from it. All of them dislike to have water thrown upon them, or even to be wet by natural rainfall. We may not from present information conclude that the chimpanzee is incapable of swimming, but we may safely infer that it lacks natural aptitude for this mode of locomotion and in all probability avoids any considerable body of water. In this respect it perhaps resembles man more closely than it does certain other primates, for many of the monkeys, although probably no one of the great apes, swim readily and strongly.

MANUAL DEXTERITY

Dexterity in the use of extremities, handedness, footedness, and natural ability to use objects as tools or to convey them from place to place, are of special interest to the comparative psychobiologist. The remarkable dexterity of the chimpanzee is beyond question, and although the available data are taken primarily from captive specimens, there is excellent reason to believe that they apply in general to the genus. Skill and certainty in carrying small breakable or fragile objects have repeatedly been noted. We cite as examples two instances.

In his fascinating story of his pet chimpanzee "Toto," Kearton (1925, p. 88) tells of the snatching by the animal of a valuable antique cut glass sugar bowl, which forthwith was carried to the branch of a tree some sixty feet from the ground. Subsequently it was returned to its owner undamaged. One of our chimpanzee subjects one day took from an unsuspecting attendant a small watch and hastily climbed out of reach with it. The owner, unfamiliar with the more than human dexterity of this animal, feared its destruction and permanent loss, but within a few minutes it was returned whole.

Comparable with these observations is the well-established fact that the animals are capable of handling potentially dangerous objects, such as sharp pieces of glass, bits of metal, knives and other sharp instruments, without injury to themselves or to companions. In such instances dexterity extends from the use of the extremi-

ties to the mouth, the trunk and the limbs, for objects may be carried in the groin, mouth, or in hand or foot.

Because of the surprising nature of the facts, and their relation to manual dexterity, we quote the following concerning opposability of hallux and pollex.

> We observe also in the chimpanzee a contrast between the grasping power of the big toe, which is a kind of thumb, and the lack of that power in the hand, in which the thumb is nearly useless; in all apes this function is characteristic of the foot, in man of the hand alone. The *opposable thumb,* with its power of bringing the thumb against each of the fingers, is the one character which is lacking in every one of the anthropoid apes and which was early developed among the ancestors of man. (Osborn, 1915, p. 55.)

And surprising also, in view of such evidences of dexterity as those above reported, are the assertions of Drescher and Trendelenburg (1927, p. 633) that in their movements the anthropoid apes in contrast with certain monkeys are slow, and especially in finer grasping movements of fingers and toes relatively unskilful. This they attribute to the short thumb, with its presumable unopposability. In tasks which require skilful use of the fingers they [the chimpanzee and orang-outan] are at a disadvantage as compared with the monkeys.

Objects are commonly handled by the chimpanzee, carried about, and even used for specific purposes, as has been many times demonstrated in experimental observations. The use of branches of trees or sticks as weapons, although many times questioned by competent authorities, is demonstrably possible, but it is extremely doubtful whether such behavior is of common occurrence among free wild specimens. Moreover, except with practice, as in the case of man, objects are handled and used clumsily, even if with evidences of insight. Detailed consideration of the use of objects as instruments or tools logically belongs in a later chapter, and we therefore postpone consideration.

A surprising amount of attention has been given to the question of handedness, and it is variously asserted that it naturally exists or does not exist in this great ape. Thus, Rennie (1838, p. 67) asserts of the much-written-of London chimpanzee "Tommy": "We observed that he used the right hand in preference to the left, and had obviously greater power and facility of action with this than with the opposite member." And the experienced animal trainer Sheak (1924, p. 127) observes that "most chimpanzees are decidedly right-handed, but Joe was left-handed." A case of left-handedness is recorded by Deniker (1882, p. 340), and by Mollison (1908, 1910-11) the genus is classed as left-handed. We have failed to discover justification for the statement of Sheak that the animals are mostly right-handed, and although numerous instances of preference for the one or the other hand have been discovered, it would appear that these may be environmental accidents.

Our own observations agree with those of other authors in indicating that a particular specimen may be either right- or left-handed, but they further indicate that the hand preference may vary from time to time and in accordance with the nature of the activity in point. Furthermore, preference is not limited to the hand, but extends to foot and even to eye, as is indicated in the following quotation: "We humans ordinarily are either right- or left-handed. It is less generally known that most of us also are either right- or left-eyed. Köhler discovered this fact in a young chimpanzee whose vision he investigated." (Yerkes, 1925, pp. 100-101.)

Rhythmic movements of hands, feet, legs, or arms are frequently exhibited by the chimpanzee, and its appreciation of rhythm is fully established. There are numerous records of drumming on trees, the earth, or parts of its own body, and also of dance-like performances. We shall cite a number of supporting observations.

Chest-beating, a characteristic activity of the gorilla, has rarely been noted in the chimpanzee. Indeed, we are able to cite only one report, that of Hans Paschen, who is quoted by Heck (1922, pp. 658-

659). This author, in describing a gorilla, mentions the fact that the same drumming of the fists on the breast is observed among chimpanzees. An old male, estimated to weigh one hundred and twenty pounds, when approached stood in "war-like attitude, striking himself upon the chest and emitting a raging bellow." Despite this account, we believe that chest-beating is rarely indulged in by the free or captive chimpanzee and that, while characteristic of the gorilla, it is entirely exceptional and of a different sort in the chimpanzee.

Curiously interesting in this connection is the following quotation from Reade (1864, p. 184):

> When I asked if the gorilla made a noise like a drum by beating on his breast, I was told "No"; but that the chimpanzees had drums, and often came to beat them near the village. . . . But I afterward mentioned it to Etia who replied that to say the chimpanzees had a drum like theirs was not true; but it was true the chimpanzee had a drum, and that he beat it with his feet. I said that I should like to see this drum. He took me into the wood, and showed me a large tree called *oreva*. It was hollow, for I could see where a porcupine had burrowed in it. This was the chimpanzee's drum, he said; and, catching hold of two young trees, he swung himself in the air, and beat with the soles of his feet against the tree. I must confess that I heard no sound like that of a drum; but he told me that the chimpanzee did it "so strong-strong-strong" that one could hear a booming noise ever so far away.

Somewhat earlier, but less circumstantially, Savage and Wyman (1843-44, p. 385) reported from hearsay that chimpanzees occasionally gather in companies and engage in hooting, screaming, and drumming with sticks, hands, or feet upon logs. Likewise, Livingstone (1875, p. 324) in his journal states that the Soko, by him misnamed gorilla, and actually a chimpanzee, may beat hollow trees with its hands and scream as music to the beating. By Heck (1922, p. 656) Haberer is cited as considering it "not impossible that the natives have taken their first impulse to the notable method of drumming, a method which is well developed in certain regions of the Kamerun, from the drumming and stamping which the chimpanzees ordinarily practice."

Offering a picture of the social setting and function of the drum, together with certain description of rhythmic movement, is the following excerpt:

> One of the most remarkable of all the social habits of the chimpanzee, is the *kanjo*, as it is called in the native tongue. The word does not mean "dance" in the sense of saltatory gyrations, but implies more the idea of "carnival." It is believed that more than one family takes part in these festivities.
>
> Here and there in the jungle is found a small spot of sonorous earth. It is irregular in shape, but is about two feet across. The surface is of clay, and is artificial. It is superimposed upon a kind of peat bed, which, being very porous, acts as a resonance cavity, and intensifies the sound. This constitutes a kind of drum. It yields rather a dead sound, but of considerable volume.
>
> This queer drum is made by chimpanzees, who secure the clay along the bank of some stream in the vicinity. They carry it by hand, and deposit it while in a plastic state, spread it over the place selected, and let it dry. I have, in my possession, a part of one that I brought home with me from the Nkami forest. It shows the finger-prints of the apes, which were impressed in it while the mud was yet soft.
>
> After the drum is quite dry, the chimpanzees assemble by night in great numbers, and the carnival begins. One or two will beat violently on this dry clay, while others jump up and down in a wild and grotesque manner. Some of them utter long, rolling sounds, as if trying to sing. When one tires of beating the drum, another relieves him, and the festivities continue in this fashion for hours.
>
> I know of nothing like this in the social economy of any other animal, but what it signifies, or what its origin was, is quite beyond my knowledge. It appears probable that they do not indulge in this *kanjo* in all parts of their domain, nor do they occur at regular intervals. (Garner, 1896, pp. 59-60.)

The appearance of dance movements, often noted, has been described with reasonable adequacy by certain authorities. A relatively early reference is that of Rennie (1838, pp. 66-67) who of the captive specimen Tommy says:

> He was, without exception, the only animal we have ever seen that could leap, or jump upon his hind-feet, like man; and this feat he often performed, both on the floor of his cage, and in de-

scending from his tree, or from the bars of the cage, up which he often climbed for the purpose of seeing over the heads of the spectators. He frequently indulged, too, in a kind of rude stamping dance, perfectly similar to that of a child of three or four years old, only that it was executed with greater force and confidence. All this arose from the uninterrupted spirits and buoyancy natural to the infant mind; he was at all times cheerful, lively, and perpetually in motion, from sunrise to sunset, either jumping, dancing, or cantering about his cage, romping and playing with the spectators, or amusing himself by looking out at the window.

Rhythmic vocalization and body movements are attributed to a captive specimen by Romanes (1889, p. 377); and dance-like activities related perhaps to sex are described by Heck (1922, p. 661), Rothmann and Teuber (1915, p. 10), and Köhler (1921c, 1925). From the latter author we quote a passage which covers not only his own observations but certain of those also of Rothmann and Teuber.

Rothmann and Teuber have described a curious habit of these animals; they sometimes tear along (as if possessed) by the walls of their sleeping-dens, and kick them till the excitement subsides. My colleagues consider this to be a sort of sex dance. To me it has never looked like this, but rather as the explosive culmination of one of those strange fits of excitement, whose character and origin are still riddles to us. And I am the less inclined to speak of *dance rudiment* here, as there are other activities of these creatures (quite unlike their frantic "fits" whose mood it is easy to recognize), which one might far more easily take to be the primitive stages of dancing. One lovely fresh morning Tschego and Grande were playing together on a box. Presently Grande rose upright and with bristling hair, in her characteristic, pompous and would-be-terrible manner, began to stamp first one foot and then the other, till the box shook. Meanwhile, Tschego slipped from the box, rose upright, and slowly revolved round her own axis in front of Grande, springing clumsily and heavily—but springing—from one foot to the other. They appear to incite each other to these strange antics and to be in the best of tempers. I have frequent notes of such quaint behaviour. Any game of two together was apt to turn into this "spinning-top" play, which appeared to express a climax of friendly and amicable *joie de vivre*. The resemblance to a human dance became truly striking when the rotations were rapid, or when Tschego, for instance, stretched her arms out horizontally as she spun round. Tschego and Chica—whose favourite "fashion" during 1916 was this "spinning"—sometimes combined a forward movement with the rotations, and both revolved slowly round their own axes and round the playground.

The whole *group* of chimpanzees sometimes combined in more elaborate and semi-rhythmic *motion-patterns*. For instance, two would wrestle and tumble about near some post; their movements would become more regular and tend to describe a circle round the post as a centre. One after another, the rest of the group approach, join the two, and finally they march in an orderly fashion and in single file round and round the post. Their movements become animated; they no longer walk, they trot, and as a rule with special emphasis on one foot, while the other steps lightly; thus a rough approximate rhythm develops, and they tend to "keep time" with one another. They wag their heads in time to the steps of their "dance" and appear full of eager enjoyment of their primitive game. Variations are invented afresh with every occasion; on one occasion an ape went backwards, snapping drolly at the one behind him; often the circular common movement would be varied by individuals spinning round their own axis at the same time; and once, as the whole group were joyously trotting round a box, little Konsul stepped to one side outside the circle, drew himself up to his full height, swung his arms to and fro in time to the trotting, and each time that fat Tschego passed him, caught her a sounding smack behind. A trusted human friend is allowed to share in these games with pleasure, as well as in other diversions, and sometimes I only needed to stamp solemnly and rhythmically round and round the post twice, for a couple of black figures to form my train. If I had enough of it and left them, the game generally came to an abrupt end. The animals squatted down with an air of disappointment, like children who "won't play any more," when their big brother turns away. (Köhler, 1925, pp. 326-328.)

In the locomotor and associated activities of the chimpanzee we have made no attempt to distinguish between the primitive or structurally given and the individually acquired forms or aspects of behavior. Normally developing structure is undoubtedly responsible for many of the activities which have been described, but, on the other hand, imitative tendency, tradition, custom, and even tuition, may in certain instances play a major rôle. We have attempted merely to present what appears to be consensus of opinion or reliable observational report, and thus to exhibit both

the extent and the imperfections of our present knowledge of arboreal and terrestrial habit and their variations. We now turn to special examination of the related phenomena of nest building and resting and sleeping postures.

NEST CONSTRUCTION

No phase of the mode of life of the chimpanzee and no behavior pattern has attracted more attention or produced more useful literature than that of nest construction. In this instance, in addition to scores of casual and often erroneous or inaccurate descriptive references, there exist a few excellent specialized discussions. Worthy of particular mention among them are those of Sokolowsky (1915), Reichenow (1920), and Heck (1922). Of these, the contribution of Reichenow is by far the most extensive, thoroughgoing, and useful. From it the reader may quickly gain not only reasonably adequate knowledge of what at the date of writing was known about the nesting and sleeping behavior of the chimpanzee, but also historical perspective. Instead of merely giving a *résumé* of this important paper we propose to offer in some detail the story of the development of knowledge of this aspect of chimpanzee life from its relatively prescientific stage to the present. In following what is in the main chronological sequence, we shall as occasion demands refer to the materials of Reichenow, and we also shall treat separately of the behavior of wild versus captive animals.

Prior to the present century, descriptions, as we shall now proceed to indicate, were meager, often inaccurate, and altogether inadequate even as basis for the intelligent formulation of problems. Although we might cite scores of casual references in the older literature, we choose to begin our narrative with the observations of Matthews, who in 1788 wrote of the "Japanzees":

> They generally take up their abode near some deserted town, where the papau tree grows in great abundance, of which they are very fond; and build huts nearly in the form the natives build their houses, which they cover with leaves; but this is only for the female and young to lie in; the male always lies on the outside. (Matthews, 1788, p. 42.)

Rennie (1838, p. 78) and Martin (1841, p. 377) quote Matthews' crude description. But shortly thereafter notable observational additions to knowledge were made by Savage.

> They [chimpanzees] avoid the abodes of men, and build their habitations in trees. Their construction is more that of *nests* than of *huts*, as they have been erroneously termed by some naturalists. They generally build not far above the ground. Branches or twigs are bent or partly broken and crossed, and the whole supported by the body of a limb, or a crotch. Sometimes a nest will be found near the *end* of a *strong leafy branch* twenty or thirty feet from the ground. One I have lately seen that could not be less than forty feet, and more probably it was fifty. But this is an unusual height. (Savage and Wyman, 1843-44, p. 383.)

Judged by the later reports of other investigators, Savage's description is reliable. Not so apparently that of Du Chaillu, who with circumstantial detail describes for the bald-headed chimpanzee, *Troglodytes calvus,* the characteristics, mode of construction, and use of nests. His more important references will be found in Du Chaillu (1861, pp. 231-232, 349, 359, and 423). Peculiar to the observations of this author, and wholly unverified by other observers, is description of the nest as umbrella-like and used not to lie upon but as a shelter from the rain. We quote to this effect:

> I have watched, at different times, this ape [*T. calvus*] retiring to its rest at night, and have seen it climb up to its house and seat itself comfortably on the projecting branch, with its head in the dome of the roof, and its arm about the tree. The shelter is made of leaves compactly laid together, so as easily to shed rain. The branches are fastened to the trunk of the tree with vines, in which these forests greatly abound. The roof is generally from six to eight feet in its greatest diameter, and has the exact shape of an extended umbrella. There are mostly two of these shelters in adjoining trees, from which I conclude that male and female live together all the year. The young probably stay with the parents till old enough to build nests of their own. The ingenuity and intelligence shown in this contrivance always

struck me as something quite marvellous. (1861, p. 359.)

As there is general agreement that the chimpanzee nest is stork-like and used by the animals to lie in, the accuracy of Du Chaillu's description has been questioned, and many authorities in rejecting his observations have suspected dishonesty. Among those who have sought for explanations of his misstatements, von Koppenfels (1877, p. 418) suggests that he mistook the nest built by a chimpanzee for its young as a protecting roof, and the implication is that such being the fact an adult animal, possibly the male of the family, was seen sitting under the nest while the latter was occupied by other members of the family unobservable by Du Chaillu. The effort to discover explanation of the shortcomings of Du Chaillu's descriptions doubtless is praiseworthy, but it has proved futile, and that traveler must be suspected either of inexcusable carelessness in observation or of distortion of the facts.

Schweinfurth (1874, I, 521) remarks of the tales of the natives of the Niam-niam region to the north of the Welle, that they told of the building of nests "upon the topmost boughs of the trees—all these tales, of course, being but the purest fabrications."

Pointed criticism of the Du Chaillu description is offered by Burton (1876, I, 42-45). This traveler states that a group of natives when shown the picture of the bald-headed chimpanzee in Du Chaillu's *Explorations and Adventures in Equatorial Africa* at once recognized it, but the picture of the "neat parachute-like roof" presented as the construction of this animal (opposite p. 423 of the volume) evoked laughter and inquiry whether Mr. Burton would like to see the house of the chimpanzee. On being conducted to the spot our author observed in a tall tree:

> Two heaps of dry sticks, which a schoolboy might have taken for birds' nests; the rude beds, boughs, torn off from the tree, not gathered, were built in forks, one ten and the other twenty feet above ground, and both were canopied by the tufted tops [presumably of the trees]. Every hunter consulted upon the subject ridiculed the branchy roof tied with vines, and declared that the Nchigo's industry is confined to a place for sitting, not for shelter; that he fashions no other dwelling; that a couple generally occupies the same or some neighbouring tree, each sitting upon its own nest. (Pp. 43-44.)

Finally, Burton adds:

> I often observed tall and mushroom-shaped trees standing singly, and wearing the semblance of the umbrella roof. . . . Surely M. du Chaillu must have been deceived by some vagary of nature. (P. 44.)

The following brief comparison of nests and nest construction of gorilla and chimpanzee is misleading in that it implies that the adult chimpanzee, or at least the male of the family, rests under instead of in a nest.

> Like the gorilla, the chimpanzee builds for its young a nest like that of the stork, only with the difference that it places it in strong trees at a greater height and somewhat smaller. The male gorilla, living more upon the earth, as already remarked, passes the night at the foot of the tree carrying the nest. The chimpanzee, on the other hand, rests in the tree itself in a forking of twigs, directly under the nest of his family. Du Chaillu could easily believe that this nest erected for its young was a protecting roof. (Von Koppenfels, 1877, p. 418.)

Referring to chimpanzees of the Tanganyika region, under the name Sako, Reichart presents what appears to be an entirely reliable description of their nests. One, for example, discovered some five hundred meters from a native village, and located some three meters from the ground in a leafy tree, was slightly more than one meter in diameter and looked like the nest of a bird of prey. It was constructed of twigs bent or drawn toward the center. There was no roof or other protection above the nest, aside from the heavy foliage. It was so strongly constructed that the observer was able to sit in it safely and comfortably. Subsequently, nests located eight to ten meters from the ground were discovered. The Sako, Reichart asserts, sits in the nest and not under it, as reported by Du Chaillu. Moreover, there is no trace of

the systematic binding or tying together of branches with vines. This observer questions the assertion that the chimpanzee uses its nest only once, on the ground that he has found groups of nests, some old, some freshly constructed, and that the herds of Sako, numbering six to twenty, probably occupied the entire group. Once he discovered ten nests with one fresh one; again fifty with two or three fresh ones, and the band of animals which had spent the night in the nests was observed to number twenty (Reichart, 1884, p. 120).

Almost as puzzling as the statements of Du Chaillu are those of Garner. We quote from an early and a late publication.

The chimpanzee is nomadic in habit, and, like the gorilla, seldom or never passes two nights in the same spot. As to his building huts or nests in trees or elsewhere, I am not prepared to believe that he ever does so. I hunted in vain, for months, and made diligent inquiry in several tribes, but failed to find a specimen of any kind of shelter built by an ape. I do not assert that it is absolutely untrue, but I have never been able to obtain any evidence, except the statement of the natives that it was true. On the contrary, certain facts point to the opposite belief. If the ape built him a permanent home the natives would soon discover it, and there would be no difficulty in having it pointed out. If he built a new one every night, however rude and primitive it might be there would be so many of them in the forest that there would be no difficulty in finding them. The nomadic habit plainly shows that he does not build the former kind, and the utter absence of them shows that he does not build the latter kind, and the whole story appears to be without foundation. (Garner, 1896, pp. 51-52.)

Chimpanzees sleep in the trees, on intersecting branches. In these places they fashion beds of twigs and foliage, breaking off the small limbs nearby to further add to the structure. Here they sleep, each by himself save the mother and baby. . . . (Garner, 1919, p. 401.)

Such nests Garner reports as located from eighteen to forty feet above the ground.

This traveler's initial failure to discover the nest of the chimpanzee is difficult to explain, save on the assumption that the building of nests is restricted to certain species and that consequently in certain portions of Africa where the chimpanzee abounds, tree nests are not to be found.

Early in the present century, and perhaps with as much dependence on the reports of hunters and collectors as on scientific records, Sokolowsky was able to write with seeming assurance of nest building in the chimpanzee, orang-outan, and gorilla. He describes the structure as located in trees where satisfactory foundation is available and at heights of from six to fifteen meters. Although nothing is added to the information of the previous century by this author, a single paragraph is of sufficient interest to justify quotation:

It is of great interest, and therefore I must mention it here, that all three anthropoids in spite of characters which are so divergent from one another, build nests in the trees as sleeping places. This may lead back on the one side to a custom acquired from common ancestry, or on the other side I believe it could be brought into connection with their vagabond life. Since these apes in their search for fruits and blossoms as material for food are compelled to wander, they can maintain no permanent quarters but are compelled, as desire for food drives them, to build resting places for the night. (Sokolowsky, 1908, p. 66.)

Wholly on the testimony of African natives, Jenks offers the following brief comment on mode of rest in the Cameroons chimpanzee:

The chimpanzee of Kamerun lives in companies or bands, as does the gorilla, and, like the gorilla, he spends much of his time on the ground; but, unlike the gorilla, he spends his nights in the trees of his forest habitat. Just as the day is closing each chimpanzee makes for himself a leafy bed or nest, not unlike the large nest of a squirrel as seen in the early autumn on the leafy branches of our forest trees. At the first streak of a new day the nest is left, not to be occupied again, it is believed. The old males eventually become solitary, though the young on maturing are believed to remain in the kinship group. (Jenks, 1911, p. 61.)

The first intimation discovered by us in the literature that the chimpanzee may build nests in play is found in Schulze, as quoted by Reichenow. Of animals in Sangmelima he states:

"I found one nest near the others so that it almost seemed as if for these animals nest building

was a kind of sport. Besides many other nests which had been used before, that is, heaps of torn-off twigs in the fork of a branch, I found also one which was erected in the crown of three small trees standing in a triangle bent together. The ability to make use of a group of trees having trunks of equal height and thickness and standing so favorably together, and to construct the nests so practically, exhibits the highest intelligence and an almost mathematical vision." (Reichenow, 1920, p. 11.)

Following closely on observations of Schulze are those of von Oertzen, who in the Cameroons noted that:

The sleeping nests of the chimpanzee always are in trees at a height of five to twenty meters. The building of the nest is done by bending together a number of twigs toward the center. The animal sits upon the bent twigs while his arms stretch out to the new twigs. Dried branches or leaves are never used for building a nest, but only fresh material which is within reach of his arms. According to the thickness of the tree the thickness of the sleeping nest is determined. In the light umbrella trees the nests are almost transparent. (Von Oertzen, 1913, p. 16.)

In critical comment on description by Jennison (1915) of nest building by a captive chimpanzee, Christy maintains that it is somewhat misleading to speak of a chimpanzee's nest. The little sleeping platforms of the animal, made by bending inwards the leafy parts of small branches of saplings or larger trees, "are quite a feature of the Ituri forests." Generally they are close to the stem of the tree, often within fifteen feet of the ground. They are small structures occupied by one or two animals and never used a second night. "They are made in a minute by reaching out and pulling in the branches, bending them or breaking them off." (Christy, 1915, p. 536.)

Although interested primarily in the habits of the gorilla, Barns in the region of Lake Kivu noted also the sleeping places of the chimpanzee, which, as he remarks, were placed on the spreading branches of high trees—platforms of bent and broken branches which "may be considered as the first rudiments of our present-day gigantic structures in stone and iron." (Barns, 1922, p. 51.)

So convincing is the description of Aschemeier that it is quoted at length:

During my stay of over two years in the Gaboon District, French Congo, I was much interested in the sleeping nests or "beds" of the gorilla and the chimpanzee; and it was my good fortune to find numbers of these beds belonging to each species. Both animals, according to my observations, make their beds in as secure places as they can find, but the chimpanzee seems to favor the greatest retirement, with less chance of disturbance from its foes of the jungle. I did not see a single bed of the chimpanzee on the ground, and they were usually constructed well up in the fork or crotch of tall and quite slender trees. In no case was the nest of the chimpanzee constructed in a tree measuring over a foot and a half in diameter at the base; and the trees selected were with few branches, a good distance apart. The lowest chimpanzee bed noted was about 30 feet from the ground, and the highest (two beds here quite close together) was fully 60 feet up.

Led by his native guide to a tree containing the nest of a chimpanzee, Aschemeier ascended it to investigate.

I was quite played out [he writes] by the time I reached the bed, but I examined it as well as I could, with one arm free to investigate. It was in a crotch of the tree and was well made of leaves from the same tree together with what looked like parts of bushes from off the ground. From what I have learned in regard to the bed of the orang-utan, I should judge that the nests of these two apes are very similar. I wondered, and have since often been asked, if the chimpanzee uses the bed more than once. Reliable natives all agreed in saying that the same beds are never twice used. (Aschemeier, 1922, p. 176.)

Having thus examined progress toward definite knowledge of nest building in the wild chimpanzee, we may similarly, and before attempting a summary statement of facts, examine evidences of nest-building tendency in captive specimens.

From the Zoölogical Garden of Manchester, England, Jennison reports for a young female bald-headed chimpanzee, *Anthropopithecus calvus,* use of hay and bits of rope to fashion a nest-like structure on a narrow beam in her cage. When supplied with a branch as foundation and with hay, straw, and leafed twigs, she assembled and arranged them in nest form.

Mindful [writes Jennison] of Du Chaillu . . . we nailed suitable branches over the nest as a basis for a roof, but no attempt has been made to utilize them to form a shelter, as, of course, there is no rain in the house.

The animal spends most of her time in the nest, to which she carries all her food, even a glass of tea, which is taken up like the nesting material in the hollow of the thigh [groin].

From time to time the nest is either thrown out or falls through, and is reconstructed with fresh material.

Of peculiar significance as bearing on our suspicion that nest building is species limited is Jennison's concluding paragraph:

Having succeeded so well with this animal, similar facilities were given to three females (*A. troglodytes*) in the adjoining cage, but no attempt was made to use them. Nevertheless, although they usually sleep on the floor-level, they will carry a sack into their trees and sleep upon it. *A. calvus,* the "nest"-builder, will also take up a sack and sleep on it. (Jennison, 1915, pp. 535-536.)

Of the group of chimpanzees for a time observed in the German Anthropoid Station at Tenerife, the Canary Islands, it is stated by Rothmann and Teuber (1915, pp. 12-13) that all except one more or less definitely attempted to build nests of straw. The exception was an animal named Konsul. A mature female called Tschego, in indication of species, constructed particularly roomy and strong nests, which like the nest of the stork could be lifted bodily. The animals slept at night but not during the day, and all of them lay down to sleep as does man and covered themselves with blankets. Jerky movements often occurred during sleep, and cries suggestive of dreaming.

Comparable in various respects with report of Jennison is that of Burrell, who from Sydney, Australia, reports that a young captive male, species unindicated, constructed a nest-like resting place in a tri-prong fork of a tree, using for the purpose small boughs and suckers.

Several sticks of varied length, shape, and dimensions were then carried up and fastened in such a way as to keep the broken suckers in position and form a strong frame work. Quite a quantity of leafy branchlets were also used to form the snuggery, and when it was completed Michael squatted in the center of the structure and surveyed the surroundings as if at a loss to know what to do next. (Burrell, 1923, p. 179.)

A pet chimpanzee named Toto, which came into the possession of Cherry Kearton somewhere in East Central Africa, once, at nightfall, assembled a varied assortment of objects on Kearton's bed, with evident intent to build a nest. When these were removed and a bed of grass was supplied he betook himself to it, but observing that the natives covered themselves with blankets he snatched one of them for his own use. Kearton (1925, p. 24) states that "Chimpanzees build nests for themselves in the tree-tops: roomy, flat nests made of intertwined twigs and padded with dry grass."

Reporting as did Rothmann and Teuber on the animal subjects of the Canary Island Anthropoid Station, Köhler offers exceptionally valuable data on nesting and sleeping behavior. We refrain for obvious reasons from using either habit or instinct in this connection. To Köhler's opening sentence, as quoted below, we take exception, because it obviously needs to be qualified. We are informed by Rothmann and Teuber (1915, p. 11) that most of the specimens at the Canary Island Station were of the species *Troglodytes niger*.

Chimpanzees make nests from early infancy onwards. The full-grown female, Tschego, did the best and most remarkable work in this line. If, in the evening, she found straw heaped in a pile on her sleeping-board, she would sit on it, bend a handful slantwise from the edge towards the inside, and seat herself, or at least put her foot, on the twisted end; she would go on in this, working all round until she had formed a nest something like a stork's. The blanket was often roughly woven into it; it was used as a cover. The nests which the young animals make are much more untidy and loose; and there is usually no turning down of the edge. If, on any occasion, they take a little more trouble, their movements during the preparation of the nest are exactly like Tschego's and these by no means depend on the material used. Nests are often built during the day for fun, or at least are sketched out; a great many different materials, such as straw, grass, branches, rags, ropes, even wires are collected and used, not when

a nest is needed, but the shapes are suggested when the material is available. It may be noted, for instance, that loose green food, whether twigs growing near the animals, or brought to them already cut for them to eat, is diverted on its way to their mouth and laid aside, as it were, as the beginning of a nest. It cannot be said that this looks very intelligent: one is even reminded sometimes of some stupid habits of the chimpanzees described later, or of "fixed ideas" in human beings. In any case the behaviour of the same animals is quite different when they are clearly solving a problem. If the material under consideration is anything like stalks or twigs and if there is little of it, then we are confronted with the strange phenomenon that, whatever the circumstances, the first thing is never to make even a scanty support for the body to squat on, but to create a ring round the animal; this is always done first, and if there is not enough material, then the ring is the only thing that is made. The chimpanzee then sits contentedly in his meagre circle, without touching it at all, and, if one did not know that this was a rudimentary nest, one might think that the animal was forming a geometrical pattern for its own sake. If a tree with foliage be set up in the animals' playground, the nest-making begins by bending in the branches, and pressing them down with the weight of the body (compare the above), after a few moments like a chemical reaction. Koko, the tiny one, who had been away from Africa and the example of other chimpanzees for months, when he could yet hardly climb a tree, would still, when three metres up, bend down the branches and begin building a nest at once. Thus, in this case, we may speak of the manifestation of an "instinct," whilst chimpanzees do not, as a rule, show many other signs of behaviour which could be called by the name of this utterly unexplained riddle. In any case this is not the species of animal on which to begin such investigations. (Köhler, 1925, pp. 93-95.)

Almost point by point we are able to confirm the description of Köhler from observation of captive chimpanzees which have served us as subjects of psychobiological inquiry. The first pair with which we became intimately acquainted consisted of an immature male, species *Pan schweinfurthi marungensis*, and an immature female whose identification is uncertain. Nest-building tendency in these individuals we have thus elsewhere described:

Nest building is one of the favorite play activities of the young chimpanzee. Perhaps I should say the young male, for in this case the female was not observed to construct any tree nests, although she rarely made incipient moves toward the construction of nests on the ground. Chim sometimes built several nests in the birch trees of the New Hampshire pasture in rapid succession. Again, a week or more would pass without any move on his part toward nest construction. The performance suggests innate equipment. The little male climbs a tree and suddenly begins to pull toward him the branches and twigs within easy reach. As he draws them in he tucks them under him. Some of the branches break off and these stay in place and help to hold those which are unbroken. If the materials within easy reach are not sufficient to make a good solid nest the animal breaks off adjacent small branches and carries them to the nest. In the course of five or ten minutes Chim can thus construct a nest of leaf covered boughs, usually located 10 or 15 feet from the ground in case of my observations, which will comfortably and safely hold him. On completing a nest he commonly would try it for a short time and then turn to some other form of amusement. In no case was he seen to construct a cover or roof or to attempt to cover himself while lying in a tree nest. His interest was limited to the process of construction; use was not involved and he was seldom seen to return to old nests. He evidently preferred to make a fresh start in a new location each time.

On the ground or indoors nests may be constructed of almost any available materials—even a rug serving the purpose by being pulled together and folded.

Panzee once or twice was seen to climb a tree to look at a nest which Chim had built or to lie in it. Ordinarily, however, she paid no particular attention, either to the process of construction or to the completed nest. (Yerkes and Learned, 1925, pp. 36-37.)

Of four animals, whose age range during period of observation was approximately three to seven years, all presumably from the western coast of Africa, and all observed in the freedom of a New Hampshire pasture during several weeks either of two or three successive summers, not one attempted to build tree nests as did Chim. Nest-like arrangement of hay, straw, bits of rag or cloth and other objects on the ground or the floor of their living quarters, was occasionally observed, but in no instance was the constructive activity comparable with that of nest building in trees. It thus appears that of six chimpanzees in the period of childhood, of which all had ample opportunity to construct tree nests,

only one, and that known to be a specimen from East Central Africa and obviously of markedly different structural and behavioral characters from the others, exhibited ability to construct tree nests. We especially emphasize the fact because it suggests possible explanation for certain discrepancies in the scientific literature.

The story of nest construction has been told chronologically and at length primarily to exhibit avoidable weaknesses or defects in method of observation and report. Except for the lessons thus indicated we might far better have recorded in a single paragraph the sum of our present knowledge of chimpanzee nests, their construction, and their use. The present status of inquiry concerning nest construction suggests several interesting problems. We state them with the hope that their solution may thus be facilitated.

(1) Is nest building of two types which may be designated as tree, and, by contrast, bush or ground nests, and are both types built by the chimpanzee? (2) Is the construction of tree nests characteristic of certain species and are there other species which do not exhibit nest building or construct bush or ground nests? (3) Are tree nests constructed solely by those species of chimpanzee which are found in Central and East Central Africa, as contrasted with the West Coast area of distribution? (4) Is nest building a structurally given capacity or instead one acquired through individual experience and by imitation, tuition, or other social aids? (5) Do individuals, irrespective of sex and age, build nests for themselves or for offspring?

In resuming the facts which seem to be well established we would again refer the reader to Reichenow (1920), whose general discussion of nest construction in the chimpanzee we have already cited as of exceptional value. Certain chimpanzees build tree nests by choosing suitable location in variable relation to the trunk of the tree, sometimes between adjacent trees by bending small branches or twigs so that they form a bed-like structure sufficiently strong to bear the animal's weight. For such nests various species of tree are used. The construction may be placed within ten feet of the ground, or it may be several times that distance removed. Ordinarily the nests are freshly constructed at twilight and apparently used as a rule for only one night. They are used as beds. No covering or roof is built, but certain observations indicate

Fig. 80. Sleeping postures of the captive chimpanzee. Drawn from life by David N. Yerkes.

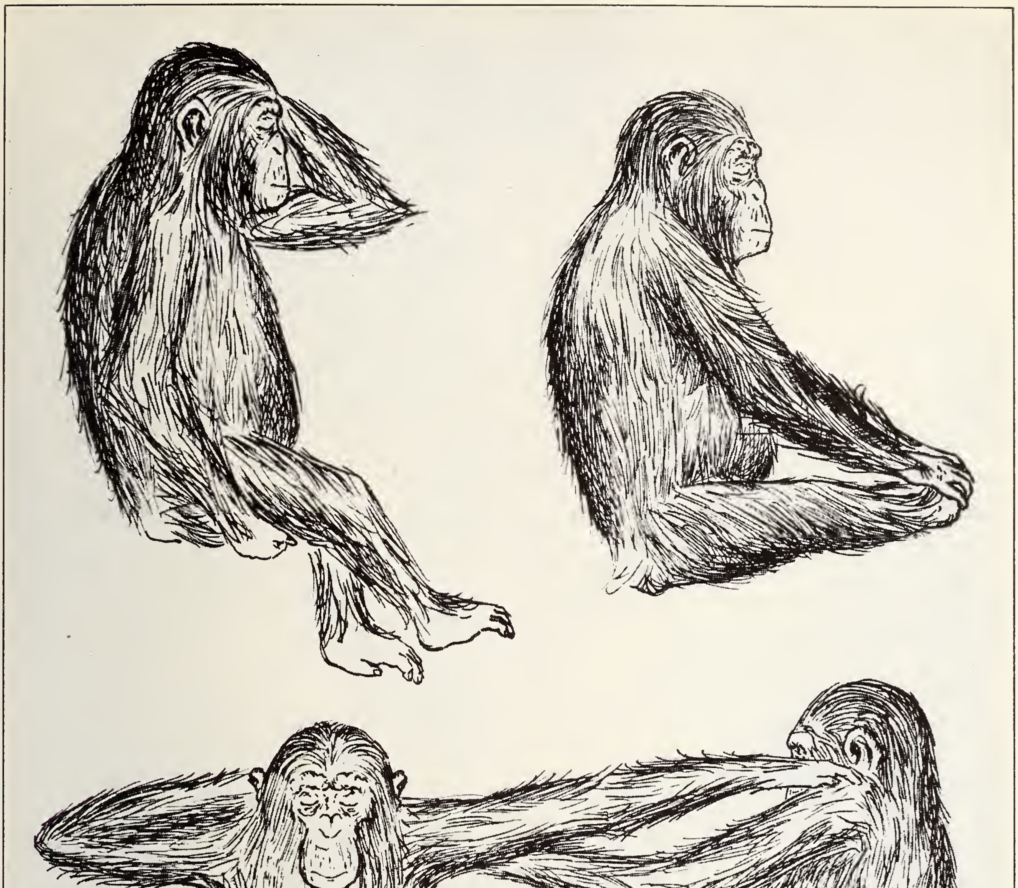


Fig. 81. Sleeping postures of chimpanzees. These individuals probably range in age from five to seven years. Drawn from life by David N. Yerkes.

that when the chimpanzee retires it may on occasion attempt to cover itself with branches or foliage. This fact is not well established and it may be restricted to certain individuals.

The sleeping posture and ways of the chimpanzee may be indicated briefly and somewhat dogmatically. There are few observations of free wild animals which bear on the subject, but those few, with the exception of Du Chaillu's, agree in indicating that the animal lies prone on some surface, usually in case of descriptions in point a self-constructed nest. We cite von Oertzen in support of this statement. It was he who observed a chimpanzee mother lying prone in a nest while a youngster played about apparently not yet ready to retire (1913, p. 16). The publications of Rothmann and Teuber (1915), Heck (1922), Köhler (1925), unpublished observations of David N. Yerkes, and observations from the Primate Laboratory, Yale University, also unpublished, definitely indicate that the typical resting and sleeping posture of the chimpanzee is on side or back. Often we have observed our specimens stretched on their backs with limbs completely relaxed. Again we have noted them lying on one or the other side, often with legs drawn close to the body. Frequently two individuals lie close together, sometimes holding to one another by hands or feet. Resting in an upright or reclining position we have observed only occasionally and during the day. Frequently we have observed during the day the young chimpanzee lying on its back with head cradled on the arms in an attitude characteristic of man.

It is established that the chimpanzee ordinarily retires for the night at twilight and continues in its sleeping place until dawn, or somewhat later if undisturbed. Although observation of wild free animals indicates that they sometimes may make outcries during the night, it is strongly suggested by the quiet sleep of captive specimens that this may be due to disturbance. At any rate, it is the consensus of opinion that the captive chimpanzee, circumstances permitting, rests quietly throughout the night. Never, save where special disturbance is responsible, have we noted other than brief and rare vocalization by our captive specimens during the hours of darkness. Whereas the wild animals probably sleep only at night, captive specimens may also sleep during the day. This undoubtedly is due to the unusual conditions of captivity, and especially to relative lack of means of amusement and necessity for life-sustaining activity.

HUNTING AND CAPTURE

Even among themselves, chimpanzees probably are not more quarrelsome than are men. Seldom are they aggressive toward man, and when approached in their wild habitat they ordinarily try to escape, but if cornered they are capable of strongly defending themselves with teeth and limbs. "They do not appear ever to act on the offensive, and seldom if ever really, on the defensive. When about to be captured, they resist by throwing their arms about their opponent, and attempting to draw him into contact with the teeth. *Biting* is their principal act of defence." Thus write Savage and Wyman (1843-44, p. 385). Aschemeier (1921, p. 90) characterizes them as cowardly by comparison with the gorilla, and notes that despite their tremendous strength when approached or threatened by man they flee precipitantly with "piercing scream" and "wild scramble." In apparent contradiction of the above statements, Honoré (1927, p. 408) describes them as moderately savage and very bold, in that they plunder the cultivated grounds of the natives.

Obviously circumstances, as well as age, sex, species, and individuality, alter cases, and it is virtually impossible to make a significant general statement which is also universally applicable. From the literature, as well as our somewhat extensive experience in dealing with captive specimens, we conclude that the chimpanzee is keen of sense, alert, cunning, wary, but also easily alarmed or terrified, and only in the rarest

exceptions dangerously and aggressively savage. Nevertheless, gentleness may not be a characteristic of adults, and especially of full-grown males.

We are puzzled by the following testimony by Christy (1915, p. 536) to the effect that the animals are relatively easy to kill with a bullet.

> They are extremely wary and noisy. When met with in the daytime they are usually in the trees. At the first alarm the big males come down from any height in two swings and a drop and make off, but the females and the rest of the troop swing and climb slowly from branch to branch. They rarely jump as monkeys do, and being too clumsy to travel quickly are easily overtaken. For such a big strong animal they are extraordinarily easy to kill. One serious body wound with a little .22 bullet is sufficient to bring them down. A slightly wounded one will make for the top of a big tree, and by breaking off branches and pushing them beneath him will in less than a minute construct a big platform, upon which he will sulk or keep up a furious screeching entirely hidden from beneath.

Christy's representation is precisely what we should not expect, especially in view of the varied evidences that the orang-outan, a structurally similar animal, possesses high resistance to injury and appears to be very difficult to kill by shooting. We have failed, however, to discover evidence definitely contradictory to that of Christy, for the descriptions offered by most hunters indicate merely that the animals are readily destroyed by gunfire.

On the testimony of natives, Jenks (1911, p. 62) reports that as the animals flee through the trees or on the ground after injury, they frequently endeavor to plug their wounds with leaves or grass.

Methods of hunting and capture are of certain practical interest and importance and may be briefly examined. Those commonly employed for the destruction of the animals by the modern hunter, whether sportsman or collector of remains, need not concern us, since for the psychobiologist they lack significance except as their use may threaten the extermination of a species. But, by contrast, means or procedures for capturing the chimpanzee alive are important. The literature contains varied descriptions of the use of pits, snares, nets, traps of various sorts, intoxicants and poisoned arrows, but seldom are they sufficiently detailed to be really useful.

Turning now to authorities, we may note that Heck (1922, p. 658) cites one Casati as affirming that beer is often used by the natives to intoxicate animals and thus to facilitate their capture. The same author tells us (p. 659) that one Stackelhausen has described the use of steel traps for the capture of a band of chimpanzees which was destroying the crops of the natives. Although not described in connection with hunting and capture, it is said that certain native tribes are able to "call" the chimpanzee (Barns, 1923, p. 147).

There is a superabundance of tales of shooting with firearms and a relative dearth of descriptions such as that now to be quoted from Schweinfurth (1874, I, 521):

> It was not my good fortune to witness a chimpanzee hunt. This is always an arduous undertaking, involving many difficulties. According to the statements of the Niam-niam themselves the chase requires a party of twenty or thirty resolute hunters, who have to ascend the trees, which are some eighty feet high, and to clamber after the agile and crafty brutes until they can drive them into the snares prepared beforehand. Once entangled in a net, the beasts are without much further difficulty killed by means of spears. However, in some cases they will defend themselves savagely and with all the fury of despair. Driven by the hunters into a corner, they were said to wrest the lances from the men's hands and to make good use of them against the adversary. Nothing was more to be dreaded than being bitten by their tremendous fangs, or getting into the grasp of their powerful arms. Just as in the woods of the west, all manner of stories were rife as to how they had carried off young girls, and how they defended their plunder.

Of the methods employed to provide "Pastoria," the medical laboratory of the Pasteur Institute located in Kindia, French Guinea, with chimpanzees, Honoré gives brief description. Four procedures are mentioned, but of them evidently only one, and that the time-honored and crude method of

the natives, seems to have proved successful. It consists in surrounding a band of animals, driving them into a tree or a clump of trees, and then felling neighboring trees so that the animals shall be prevented from escaping. Thereupon the natives form a circle about the isolated trees and by varied means frighten or otherwise force the animals to descend to the ground. They are then attacked with clubs, forks, or ensnared in nets. At times dogs are used to aid in the capture. It is not uncommon for an animal to overcome two or three hunters before being quelled by blows. Under such conditions a large proportion of the young captives are more or less wounded and the hunt sometimes ends in a veritable massacre (Honoré, 1927, p. 408).

The other three methods mentioned by this author are: hunting with pistols which discharge an asphyxiating gas, baiting the animals with seeds impregnated with alcohol, and shooting them with arrows bearing snake venom, the latter to be neutralized as promptly as possible by treatment with antivenom serum.

At once and by far the most informing and interesting contribution to the general subject of hunting and capture of the chimpanzee is an article by the experienced collector J. L. Buck. Although he refers to several of the devices and procedures which we have enumerated, Buck indicates primary reliance on the method which he says the natives probably have used since the time of Noah. This he describes in serviceable detail. A region and certain trees in which a family or a band of animals happen to be spending their nights are located and nets are made ready for a hunt. After the animals have retired for the night and darkness has fallen, these nets are quietly and ingeniously arranged about the base of certain trees. Then the hunters wait for the moment agreed on for attack. On prearranged signal, usually at break of day, the animals are driven from their nests and the trees by a startling din produced by the natives. As in panicky haste they descend, the natives gather about and having ensnared them in the nets, subdue and bind them.

Buck gives a vivid picture of a tragic closing scene in such a hunt:

> Immediately came the beating of drums and tom-toms. Every boy sent up a yell. I could hear my son snapping out an order three trees away from me, while up in the branches started the scoldings of the apes as trees swayed to the thwack of wooden poles and the raining down of foliage. A chimpanzee raid is very exciting; so many human beings feel a common thrill. The witch-doctor pounded his great drum. Our pulses throbbed. Then my son called above the hubbub: "We've got him! We've got him!" One, at least. Then—thud! In the next enclosure I heard Hector shout: "Massa no want big bo. He too plenty chimpanzee! No! No!"
>
> I crawled beneath the two net fences and came upon a rough and tumble: black legs and arms and kinky heads were "mixing it up." I saw at once what Hector meant by "too plenty chimpanzee." Through some accident the boys had shaken that full grown male out of his tree and he was tearing nets and black flesh in his fight for freedom. I have never had good luck with grown chimpanzees, and so I never fence off a tree where a big ape is sleeping. But this old fellow had perhaps changed trees in the night. At any rate, here he was, striking at everything in reach. "*Leffit! Leffit!*"—"Let go! Let go!" I called.
>
> All my own boys drew back. But a Kono boy, from the village though not originally of our party, rushed in. Perhaps he had not understood the order. Perhaps he lost his head at thought of the escape of so much chimpanzee. At the moment, the old fellow was nearly loose, and the rest happened like a rifle-shot. Out tore a pair of arms from the snarl of nets. They flashed up, ugly and vengeful, and had clutched the poor wretch about his spindling body before Hector or I could help. Then Hector's net was flung out. Mine followed. The ape, on the instant, released the boy and turned his yellow eyes on us. That lifeless body must wait. We were the new enemy. But we snared the old fellow, and then I ran for the chloroform and in a moment stood over him. (Buck, 1927, p. 310.)

The reader who would obtain practical guidance in the capture of chimpanzees unharmed, and also the "feel" of this thrilling hunting, cannot do better initially than to read Buck's article.

CHAPTER NINETEEN

HABITS OF EATING AND DRINKING, HYGIENE, AND CARE IN CAPTIVITY OF CHIMPANZEE

OFTENER perhaps than any other question, those who have chimpanzees in captivity are asked, what do they eat? Our reply is: what they are taught to, as do we! This is an intimation of our conviction that the selection, acceptance, or rejection and manner of eating foods are chiefly matters of habit, and therefore individually determined. Our experience suggests that the chimpanzee may be taught to eat almost anything which is not positively injurious. With these remarks we preface our account of the foods and the feeding behavior of the animals, because it is so generally assumed or implied that choice and manner of taking foods are instinctive and characteristic for a species.

Eating and drinking are engaging for the chimpanzee as for man. Therefore, these patterns of behavior have peculiar importance in the life of the organism and for approach to a variety of psychobiological problems. Neglecting historical perspective, since little was certainly known about the subject save from observation of captives prior to 1850, we note in quick transition to more recent work the observations recorded by Savage nearly a century ago. The dietary articles enumerated by this authority are: The tender foliage of certain trees when preferred fruits are scarce; fruits like the *Elais guiniensis,* the *Palm nut,* various "plums," only one of which is known botanically, the *Parinarium excelsum,* the *Carica papaya,* which is its favorite, the *Musa sapientium* and *paradisiaca,* and three species of *Amomum, A. azfelii, A. grandiflorum* (?), and a third undescribed; and yet others which Savage did not identify.

The strong development of the canine teeth in the adult would seem to indicate a carnivorous propensity; but, in no state save that of domestication do they manifest it. At first they reject flesh, but easily acquire a fondness for it. The canines are early developed, and evidently designed to act the important part of weapons of defence. When in contact with man, almost the first effort of the animal is—*to bite.* (Savage and Wyman, 1843-44, pp. 382-383.)

The dependence of the wild chimpanzee upon vegetable foods, affirmed by Savage, has been abundantly confirmed by direct observation of feeding animals and by the examination of the stomach contents of cadavers. The reader who desires an admirable review of the evidences, with citation of authorities, will find such in the paper of Reichenow, previously mentioned favorably because of its description of nest building (Reichenow, 1920, pp. 23-27).

Reichenow states as his conclusion that the chimpanzee is exclusively vegetarian (p. 23). We believe that the evidences necessitate qualification of this statement or substitution of such as the following. Although primarily a vegetarian, the chimpanzee does not necessarily reject animal products and may take and devour not only eggs but insects and small animals. The literature indeed proves that the only point on which serious disagreement has arisen is that of carnivorous habit. There are those who with Reichenow argue for strict vegetarianism, and others who accept as established fact the extreme partiality of certain individuals, and perhaps also species, to animal products. To the question, is the chimpanzee partially carnivorous in nature as in captivity, and do normal growth, health, and longevity demand animal as well as vegetable products, Savage, as indicated above, has given a negative reply. Meat eating, in the light of his observations, is to be considered an accident of captivity. A similar position

is maintained by von Oertzen (1913, p. 13) and other authorities. But von Koppenfels (1877, p. 418) on the contrary states that although the wild individual relies chiefly on vegetable products, it does not always reject eggs and small living animals. The case for the affirmative is presented strongly, although not in our judgment convincingly, by Falkenstein:

> In spite of the widespread prejudice one need not be concerned over giving flesh in any form to a species of ape. They teach us this themselves, if we have opportunity to observe them in the open, since with eagerness they try to catch insects, especially spiders and grasshoppers, and also to obtain birds and eggs. Rats are a delicacy for chimpanzees which they energetically defend against the encroachment of companions, and equally the gorilla requires meat to keep him in good condition. If in the forest the chase is unsuccessful he must often content himself with fruits. In the stomachs of two chimpanzees which we killed I found only vegetable remains, yet I am convinced that this was merely accidental and that under other circumstances one might readily find proof of animal food. (Falkenstein, 1879, p. 151.)

Meat eating in captivity has several times been reported. We cite an instance, which already has repeatedly appeared in the literature. Of a bald-headed specimen named Sally, sometime resident in the London Zoölogical Gardens, Superintendent Bartlett from personal observation reports thus interestingly what would appear to be a dietary vagary with associated peculiarities of feeding behavior.

> Again the habits of this animal differ entirely from those of the well-known or Common Chimpanzee. She has always shown a disposition to live upon animal food. Soon after her arrival, I found she would kill and eat small birds, seizing them by the neck, she would bite off the head and eat the bird—skin, feathers, and all; for some months she killed and ate a small pigeon every night. After a time we supplied her with cooked mutton and beef-tea; upon this food she has done well. I have never found any ordinary Chimpanzee that would eat any kind of flesh.
>
> Another singular habit was the producing pellets or "quids," resembling the castings thrown up by Raptorial birds; I have here a few of them, taken from her mouth. They are composed of feathers and other indigestible substances, that had been taken with her food. Moreover she is an expert rat-catcher, and has caught and killed many rats that had entered her cage during the night. (Bartlett, 1885, p. 674.)

Dietary requirements in the chimpanzee, as in other animals, change radically with age. Similarly, there is adequate reason to maintain that the requirements of different species, types, and individuals vary with environmental conditions. It is not particularly surprising that certain captive specimens should take to meat eating, but this far from proves the prevalence of such habit in nature. However, the extension and improvement of naturalistic research should presently exhibit the facts. In the meantime, we present as tenable the statement that this animal is a vegetarian and only under exceptional conditions adds to its dietary animal products. Furthermore, the latter are entirely unnecessary to normal growth, health, and reproduction.

Passing now to other observations on the diet of captives, we discover in numerous early and late publications enumerations of articles of diet and of various aspects of feeding behavior. Many of these are highly interesting and doubtless entirely reliable, but since their scientific importance is slight we neglect them in favor of a general description of the diet and feeding activities of the chimpanzee in captivity. The description will be based chiefly on the experience of those who in zoölogical gardens, special laboratories, or elsewhere, have over considerable periods been responsible for the care of a number of animals.

Those who keep the animals for exhibition purposes as a rule rely on vegetables, fruits, eggs, and milk as dietary staples. Rarely they supplement these with cooked meats. Relatively few experienced observers or keepers consider the latter essential to growth and health. According to Rothmann and Teuber (1915, p. 11) the chimpanzees of the German Anthropoid Station at Tenerife, the Canary Islands, were maintained on vegetables and fruits. Especially mentioned are bananas, bread, potatoes, tomatoes, although undoubtedly a greater variety of vegetable products, including other parts

of plants, was supplied. Marked individual preferences are reported by these observers, and also the fact that many articles were consistently refused by certain individuals,

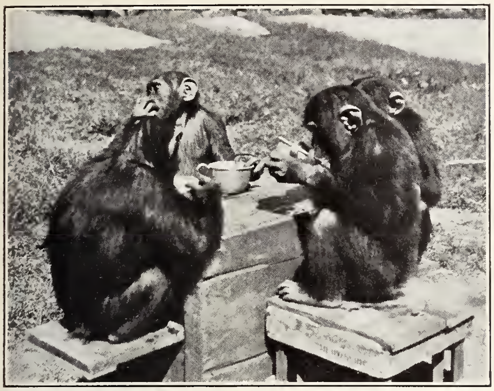


Fig. 82. A group of chimpanzees from the Yale Primate Laboratory at dinner.

although eagerly taken by others. It is evident from the records of this station, as from our own observations, that at the dinner table of the chimpanzee, as at our own, accidents of appetite and habit are commonplace.

Useful for those who would learn how to care successfully for captive chimpanzees are the descriptions given by Yerkes of his experience and his observations in the Abreu anthropoid colony at Havana, Cuba.

The care of the animals would have been simple enough except for the illness of Panzee. They were fed regularly three times a day, the mid-day meal being light, and their dietary was varied. Meats and eggs they consistently refused, but they more or less willingly and eagerly accepted oatmeal, corn meal, rice and hominy boiled and served warm with milk; vegetables—especially carrots, lettuce and, in Panzee's case, tomatoes; berries as represented by blackberries and raspberries; fruits, more particularly apples, oranges, bananas, peaches and pears. Fruits were preferred to all other foods. Cereals were used largely because of availability and convenience. Coarse bread, including corn, whole wheat, and bran, were taken occasionally but not eagerly.

They were extremely partial to milk, slightly warmed, and each was given about a pint a day during the first few months. Either Klim (milk powder) or pasteurized milk were used. Chim takes water in considerable quantity, whereas Panzee usually refused it except when warm. Usually in the middle of the day each animal was given a cup of weak tea and in addition Chim often had about a half-pint of water. (Yerkes and Learned, 1925, p. 26.)

This description has been quoted chiefly because the one individual was healthy and hearty, the other sickly and consequently difficult to feed. Subsequently it was discovered that Panzee had intestinal tuberculosis. From experience we hazard the assertion that a major part of the difficulties met in teaching newly captured animals to eat or in accustoming them to new foods is due to indisposition.

The experience and degree of success of Mrs. Rosalia Abreu in maintaining a colony of chimpanzees in health and contentment and in breeding them in captivity are notable. Her dietary provisions and practices we have elsewhere described in serviceable detail (Yerkes, 1925, pp. 209 ff.).

A group of chimpanzees kept for psychobiological studies in the Primate Laboratory of the Institute of Psychology, Yale University, has since 1924 been kept in healthy vigorous condition on a diet which we may thus briefly describe. The daily ration includes as staples cooked mixed cereal (corn, oats, wheat, rice); milk

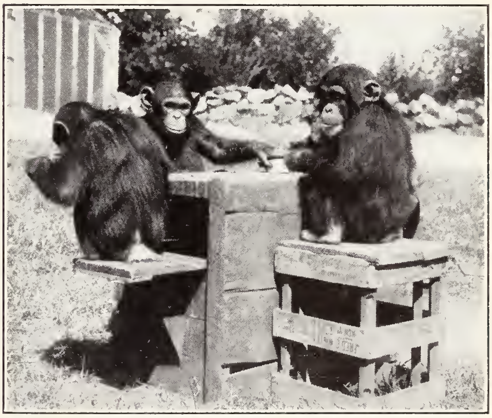


Fig. 83. Dinner time! Chimpanzees from the Yale Primate Laboratory.

(whole milk powder is used for convenience and safety from microörganisms in preference to fresh milk); some green vegetable, for example, lettuce, cabbage, or carrot; and

also some fruit, for example, banana, raw or cooked, orange, or apple. As contrasted with this daily ration, raw peanuts are fed at intervals, and cod liver oil is given irregularly and especially on sudden drops in temperature or when symptoms of "colds" appear. The cooked foods commonly are given warm, as is also tea which is provided at midday, while the principal meals are given morning and evening. Milk and water in addition to the tea are given in quantities which vary with age and desire.

Both free and captive chimpanzees eat with cleanliness, but in the presence of an abundance of food, wastefully. The mode and especially the rapidity of eating vary with appetite, the nature of the food, and the social situation. Threatened competition induces effort to gain possession and to hold at command as large a supply as possible. It also favors extreme rapidity of eating. Such phenomena, described by Köhler (1925, pp. 285-286), we also have observed. Also we have noted that an individual fed in isolation presently comes to eat in a leisurely way, unless ravenously hungry. Individual preferences, so often remarked, are particularly conspicuous in young captives. One may not reasonably doubt their existence also in free wild individuals.

No newly captured specimen may be expected to eat readily and at once. Certain individuals are sure to prove wholly refractory, others may more or less quickly be habituated to an adequate diet and to normal natural feeding.

Habits of taking regularly a certain place at table, of eating neatly with the aid of spoon or fork, and of skilfully taking solids or liquids from dishes without either spilling or breakage, are readily established. Indeed, the literature contains a great many descriptions of such adaptations of feeding behavior. In the Yale Primate Laboratory, as a matter of routine each individual is required to take its assigned place at the dinner table where it receives its portion of food by courses. Thus each member of the colony is assured of the appropriate amount and variety of food.

Fig. 84. Young chimpanzee drinking milk from a bottle.

Anyone who examines the entire behavioral literature of the anthropoid apes will notice that whereas for the gibbon and the orang-outan there are many accounts of modes of drinking, for the chimpanzee there are none except in captivity. The scant evidence which we have been able to discover indicates that the wild chimpanzee drinks usually by applying its lips to the liquid. They may be protruded funnel-like or the lower lip may be extended like a shovel and thus offered as a receptacle for the liquid. No mention has been found of use of the hands to dip the water or of licking it from the hair of arms and hands, as is common in the gibbon and possibly also in the highly arboreal orang-outan. The chimpanzee is usually found near a water

supply; and the fact that the animals will readily take various liquids justifies the inference that in nature they drink, in addition to water, the liquid products of various plants, as, for example, the sugar cane, bamboo, cocoanut palm.

The captive chimpanzee drinks from stream or faucet, cup or larger container, by applying its lips either as stated above or in human fashion. Authentic records definitely establish the fact that certain captives at times have willingly taken such liquids as beer, wine, gin, coffee, tea, cocoa, milk, and even water! Childlike, the animal is peculiarly partial to sweet substances, and it may be induced to take almost any liquid or solid by the addition of sugar or suitable substitute.

HABITS OF CLEANLINESS

Cleanliness and personal hygiene, like most other aspects of behavior, are imperfectly and entirely inadequately known in the wild chimpanzee, while pertinent statements concerning captives are variable and to a surprising extent contradictory. From numerous brief references to the topics we cite certain typical observations.

Of the often described London captive Tommy, we are told by Rennie (1838, p. 69), "in his habits he was peculiarly cleanly." And Sayers (1839, p. 29) says the animal is extremely cleanly, "never soiling his bed or any place near it." On the other hand, Savage and Wyman (1843-44, p. 385) state that chimpanzees are very filthy in their habits, that they are coprophagous, and that among certain natives it is traditional that, once members of their own tribe, they were expelled from human society on account of their depraved habits. Perhaps it may reasonably be inferred from the latter information that Savage and Wyman applied the term filthy because of the reputation of the chimpanzee among natives rather than because of personally observed uncleanliness.

A captive specimen kept by Heck is said to have been very untidy at first, but later as he became accustomed to his captive environment to have endeavored to keep his body, room, and bed in good condition (Heck, 1922, p. 667). With laudable caution and conservatism, Sonntag (1924, p. 90) tells us that "it is frequently stated that the Chimpanzee is filthy in its habits, but many examples in captivity do not manifest this trait, nor any tendency to immoral behaviour."

From the Canary Island Anthropoid Station it has been reported by Rothmann and Teuber (1915, p. 11) that all of the captive chimpanzees (seven originally referred to) were more or less coprophagous, perhaps because of long imprisonment in small crates or cages prior to provision of more nearly adequate quarters at the Station. Nevertheless, these animals were particular in the care of their bodies and no vermin were found on them (p. 14). Of the same group of animals coprophagy is reported by Köhler (1925, pp. 6, 83, 309). From this author we quote a descriptive paragraph, the chief points in which are verifiable from our own observations.

> Chimpanzees often smear themselves with excrement, either their own or their comrades'. Here a curious point of contrast must be recorded. I have only observed one of this species who did not take to coprophagy during captivity (Koko, to wit). Nevertheless, if one of them steps in excrement, the foot cannot as a rule tread properly after—as would also be the case with us. The creature limps off till it finds an opportunity of cleansing itself, and that by preference *not with its hands* (though it may, a few minutes before, have lifted similar filth to its mouth, and refused to leave go, even when it was given sharp blows on the hand), but with twigs, rags, or pieces of paper. As the ape's behaviour and expression are plainly indicative of discomfort, there is no doubt that filth *on the surface of its body* is disagreeable to it. This always happens when the body is soiled in any way. The naked hand is not used to remove it, but it is rubbed with rags, etc., or against the wall, or the ground. (Köhler, 1925, pp. 83-84.)

Of importance as a gauge of mental status is the tendency of the animals to use objects as implement to clean the skin.

Referring more generally and inclusively to personal hygiene, Köhler from his extensive experience observes:

The animals in the zoological gardens, I am told, sometimes behave in a very ugly manner; the chimpanzees of the station are, without doubt, very dirty creatures in the usual sense, in spite of the care that they devote to each other's bodies, and are certainly very greatly "coprophagous," but their sex-cleanliness could scarcely be greater; I have only seen little Koko, once, while hopping about in a fury, but on no other occasion, happen to masturbate; and then it was obviously quite accidental. (Köhler, 1925, p. 100.)

A somewhat more detailed account of bodily and sex cleanliness in the pair of captive chimpanzees previously referred to as Chim and Panzee is quoted herewith.

Apart from certain exceptional conditions, both chimpanzees were cleanly in their habits. In the quarters provided for them in Washington, D. C., a simple toilet arrangement was installed, consisting of a galvanized iron pan about 3 inches deep by 15 by 18 inches. This pan was placed on the floor of the cage in one corner and held by wooden cleats which prevented the animal from displacing it. From the side of the cage it could be withdrawn by the attendant to be emptied and washed. Extending diagonally across this pan from one corner of the surrounding frame to another was a strip of wood 2 inches wide by 1 inch thick, on which the animal could stand. Chim evidently understood the purpose of this toilet device from the first. He used it commonly, although not regularly. "Out of sight, out of mind" perhaps accounts for his lapses. Panzee was less reliable, but she also seemed to understand our intent in installing the toilet. Altogether the device worked fairly well, and we experienced no unreasonable difficulties in keeping the quarters tidy.

The nest or bed arrangement consisted of a wooden box 14 inches deep by 32 by 18 and ½ inches (inside), in the bottom of which fitted snugly two galvanized iron pans, which were of the same dimensions as the toilet pan. These could readily be removed to be emptied and cleansed. Covering the pans, and also removable, was a piece of heavy wire netting, 1 inch mesh, and on this in turn was placed a burlap bag containing coarse shavings or excelsior. This served as a mattress. The bed was made up each evening and in the morning the mattress was taken out to be dried in the sunlight and the screen and pans removed and cleaned. Undoubtedly a hammock would have served quite as well as the mattress. The latter was used chiefly to assure sufficient warmth to Panzee. She was very partial to a woolen blanket and when given a small white blanket she would take particular pains not only to cover herself neatly and effectively, but to keep it clean. Almost certainly her great care in this respect was due to training before she came into my hands.

In sex behavior and cleanliness my chimpanzees differed markedly from those observed in the Canary Island Station. The latter, because of long periods of confinement in small cages, were filthy in their habits, whereas my animals were tidy. On the other hand, Chim, when received by me, had the habit of masturbating, whereas the reports of the Canary Island observers indicate the absence of this habit in their animals. (Yerkes and Learned, 1925, pp. 28-29.)

From the information of the literature, as supplemented by our own observations, we would tentatively suggest the following general statements as applicable. The wild free chimpanzee is by nature particular about the cleanliness of its body, and although it may on occasion be coprophagous, there are no observations to justify dogmatic statement. Neither are there indications of sex perversions or masturbation. Captive specimens exhibit many and extreme variations in degree of cleanliness and the nature of personal hygiene, primarily we may assume because of the accidental and often highly unfavorable conditions of confinement. Under reasonably good conditions the following description is likely to apply. The animals are extremely careful of their bodily condition, dressing skin and hair frequently, and avoiding unnecessary soiling of the body. They do not ordinarily bathe themselves with water. Their attitude toward bodily excretions, although highly variable, is in general that of avoidance.

NATURE VERSUS NURTURE

The word instinct seldom occurs in the behavioral literature on the chimpanzee. Two reasons have occurred to us for this state of affairs: first, the animal has rarely been observed during the period of life when so-called instinctive activities are most frequently and most clearly exhibited (namely, infancy), and second, its behavior as ordinarily observed gives in marked degree the impression of variability, adaptability, and insight instead of regularity, fixity, and blindness. Naturally if the generally accepted characteristics of instinct do not ap-

pear, the term is not likely to be applied. But whatever the correct explanation of the fact which we have reported, it is entirely improbable in our opinion that there are fewer "instincts" in the chimpanzee than in man. We submit that almost certainly it is wholly a matter of observation.

Ten principal human instincts, or perhaps assemblages of primitive types of response, each with its appropriate type of emotional experience, are listed by McDougall:[1] flight, repulsion, curiosity, pugnacity, self-abasement and self-assertion, parenthood, reproduction, gregariousness, acquisition, construction. We mention them not to characterize or justify the proposed categories but instead to point out that activities which belong in one or other of McDougall's classes and which may be in varying degree instinctive, that is, primarily conditioned by the hereditary structure of the organism, may be exhibited by the chimpanzee. Indeed, from our present knowledge of it scores of examples might be mentioned.

Our difficulty, as previously pointed out, in applying the terms instinct and habit is that descriptions rarely make sufficiently clear the characteristics of an act to justify the application of either term alone. Consider nest building, for example: Is this activity in the chimpanzee instinctive, habitual, or both? Examination of the literature fails to supply an answer. One may assume from personal bias or estimate of probability that it is primarily the one or the other, but may not safely make dogmatic statement.

Turning then to the evidences which are available, we discover that chimpanzee activities which may safely be referred to as instinctive are few. We shall draw chiefly from the observations of Köhler, many of which we have personally verified or supplemented. This authority suggests as possibly in the main instinctive, examination and manipulation of hair and skin, the characteristic manipulation of wounds or other forms of injury, nest building, and decorative adornment (1925, pp. 320 ff.).

[1] William McDougall. *An Introduction to Social Psychology*. London, 1908, pp. 45 ff.

Köhler took considerable pains to disprove the assumption that the tendency or acquired ability of the chimpanzee to arrange boxes in pyramidal form in order to obtain suspended food, or to use sticks in practically serviceable ways, is instinctive or impulsive rather than intelligent (1925, p. 144).

We have labored thus to say something about instinct because, despite paucity of information, it is obviously of fundamental importance to discover the history as well as the characteristics of activities. Not until this is achieved for the chimpanzee, as for any other type of organism, can the terms instinct and habit be applied with assurance and accuracy. It is awkward indeed to avoid their use; yet even the awkwardness of our description may have certain practical value as disagreeably emphasizing the inadequacies of our knowledge of even the most readily observed and most obviously important activities of the chimpanzee.

DOMESTICATION

We have discovered nothing in our study of the literature to justify the assumption that the chimpanzee, prior to experience of man's destructiveness, was unafraid; but the possibility is not precluded. For long before the white man entered its habitat, the black man may have aroused its suspicions. Human experience through the ages has amply demonstrated that when captured young it may be tamed, rendered gentle, and trained with considerable ease and facility. The more advanced the age, the more difficult are these processes. Often it is asserted that a wild chimpanzee captured when mature cannot be tamed. We doubt not that exceptions are discoverable. During the last two hundred years undoubtedly thousands of these animals have been captured and in varying ways trained. Yet never, so far as the literature reveals, has an individual been subjected to servitude or

truly domesticated. Some at least of the reasons for the failure of efforts toward domestication will appear in the following paragraphs.

Domestication, as contrasted with taming or gentling, means, we take it, the subjugation of an animal to the will of man and conversion of its activities or the products of its activities to human uses. There is a strange dearth of discussions of this possible relationship of the chimpanzee, or indeed of any anthropoid ape, to man. A single general article has come to our attention and we favorably mention it as a suitable introduction to the subject. It is Gudger's *Monkeys Trained as Harvesters: Instances of a Practice Extending from Remote Times to the Present.* Although in the main Gudger considers evidences of domestication of the infra-anthropoid primates, in the following paragraphs he offers certain ancient references to the chimpanzee:

Edward Tyson closes his *Philosophical Essay concerning the Pygmies of the Ancients,* published in 1694, with a reference to the activities of certain trained monkeys as recounted by three authors antedating him. Instead of giving this citation, the authors concerned will be quoted directly. It is perhaps needless to caution the reader that they wrote at a time when nature-faking was not condemned as it is today.

In 1670, Olfert Dapper published his book on Africa, and in his description of "Sierra-Liona" is found the statement appended below. There is no evidence that Dapper ever visited Sierra Leone, nor is there any to show from whom he got his information though he may have known of the citation immediately following this one. His words are:

"Three kinds of monkeys are found here; and there is one, of a certain species they call Baris, which they catch when little; raise, and train so well, that these monkeys can give almost as much service as slaves. Ordinarily they walk quite erect like men. They can grind millet in the mortar, and go to draw water in a pitcher. When they fall down, they show their pain by cries. They know how to turn the spit, and to do a thousand clever little tricks which greatly amuse their masters."

Going back still farther, in Petri Gassendi's life of the French scholar, Peiresc, published in 1641, is found the following interesting statement which agrees with the foregoing, in so far as the author's very unclassical Latin can be made out.

Peiresc was informed by a certain physician named Natalis, that in Guinea a particular kind of monkey called Baris was of so gentle a disposition that it could be readily trained, taught to wear clothes, play on a pipe, husk grain in a mortar, assist in keeping the house swept and in order and in performing various other menial services. (Gudger, 1923, pp. 275-276.)

So much for historical perspective. We hasten to present examples of more recent observation and report. Boitard (1842, p. 6), on the basis of native reports, says the chimpanzee in captivity may render as good service as a negro, and of a particular specimen seen at Loango, that she fetched water in a gourd, wood from the forest, swept, made the beds, turned the spit, and rendered other like domestic services. Possessing the earmarks of rumor instead of observationally established fact are also the references to domestication found in Reade (1864, p. 184). In the interior of Sierra Leone it is commonly reported that the chimpanzee is tamed by the natives, who teach it to pound maize in mortars and to fetch water. This author with insight adds that the statement is badly authenticated.

These few examples will suffice to indicate the inadequacy of information. The evidences of true domestication are few and relatively untrustworthy. Why this is the case we shall attempt to indicate by describing certain characteristics of the chimpanzee which obviously enough in a measure explain the difficulty of domestication. Although from our own work we might cite essentially similar observations, we have not published them in detail; and we therefore take from Köhler a description of the behavior of a chimpanzee captive which is characteristic and illuminating.

When one tries to make an ape do something which he does not feel like doing, the effect of this pressure, as a rule, is merely that the greatest opposition is offered against doing what is wanted, just as, while it is possible to pull a chimpanzee's arm in play, the moment the pulling in any way restricts its liberty, the muscles are at once tightened in the opposite direction. None of the animals were as obstinate as Sultan, and his behaviour, when I wanted to force him to perform a test, was like that of a wayward child. One

day, when he had begun lazily to make a choice between two objects and I applied pressure, I found it impossible to make him do anything any more, not even to take in his hand the stick with which he was to choose. The other animals were fed, but not Sultan, and still he would not touch the stick, although he would have been able to get his food with it immediately. I put the others to bed and still Sultan remained stiff-necked. Then from a hiding-place I noticed the following: when evening came and it grew colder and less comfortable, he at last took the stick, scraped around the ground in his room with it, but exactly in the opposite direction from where the test-objects were. After a time he pushed it through the bars, and scratched about sideways in the sand, as though he were playing. Then he dropped the stick again, but after a few moments picked it up, and so it went on, until at last he made the simple choice and the right one, which I had demanded of him. When I had put him into his sleeping-den, there was a frenzied scene of reconciliation, such as I have before described.—The same animal behaves quite extraordinarily, when one tries to teach him something in which he is not interested. Once, it was demanded of him, in the evening after all the animals had been fed, to collect all the fruit skins which were lying about, and put them in a basket. He quickly grasped what was required of him, and did it—but only for two days. On the third day he had to be told every minute to go on; on the fourth, he had to be ordered from one banana skin to the next, and on the fifth and following days his limbs had to be moved for every movement, seizing, picking up, walking, holding the skins over the basket, letting them drop, and so on, because they stopped dead at whatever place he had come to, or to which he had been led. The animal behaved like a run-down clock, or like certain types of mentally-deficient persons, in whom similar things occur. It was impossible ever to restore the matter-of-fact ease with which the task had at first been accomplished. I was also never able to achieve any essential improvement in the period of my presence on the island by frequently repeating prohibitions and supporting them by punishment. (Köhler, 1925, pp. 307-309.)

At once typical and highly significant, this behavior gives us the key to the chimpanzee's relation to man, and especially to its resistance to domestication. Naturally or artificially acquired interests play their conspicuous rôle in motivation of the animal, but when under compulsion it is required to perform an act regularly and repeatedly, it strongly resists and exhibits not only stubborn determination to have its own way but at times also ill temper. An important pedagogical lesson may well be taken from this description of anthropoid behavior; namely, that natural interest is more valuable than compulsion and that pedagogical procedure should endeavor to use natural interests and to augment and create them. Lacking the factor or factors of natural interest, motivation is likely to be unsatisfactory.

We conclude then, again tentatively instead of dogmatically, that the chimpanzee is relatively incapable of domestication and that its services to man are likely to be of entirely different order, perhaps chiefly because of its nearer approach to the temperamental and intellectual characteristics of man, than those of either ordinary house pets, such as the cat and dog, or domesticated cattle.

But when we turn from the problem of domestication to that of training for stage performance or tricks which involve something in the nature of play acting, the story is very different. An abundance of well-authenticated observations justify the assertion that the animal is a natural actor. Intelligent specimens are readily trained and take delight in their performances. In fact, the chimpanzee is by all odds the most docile of the anthropoid apes and the most valuable as a stage performer. During the centuries many specimens in Europe and America have become well known and the characteristics and performances of several of them have been described often in popular and scientific publications. In our citation of authorities below we have neglected the purely popular accounts and have mentioned but a few of the approximately scientific sources of information: Hagenbeck (1909), Knauer (1915), Marbe (1916-17), Heck (1922), Sheak (1923, 1924), Hornaday (1922, 1925).

DISEASES AND DISABILITIES

Of the diseases and disabilities of the free wild chimpanzee next to nothing is known,

and of those in captivity too little for our safe practical guidance. At the end of the last century Keith (1896, p. 258) in brief comment on the status of the pathology of the chimpanzee could write: "Nothing is known of the diseases to which the chimpanzee is subject in its native surroundings; in Europe it commonly falls a prey to diseases of the respiratory system." And in support of this statement only four references were offered.

A quarter of a century later Sonntag in a monographic account of an individual specimen virtually repeated Keith's statements, and added to respiratory disorders diseases of the digestive and skeletal systems. As a significant exhibit he offered a list of the thirty-four specimens deceased in the London Zoölogical Gardens between 1882 and the date of writing, 1923, a period of approximately forty years. Length of life in the Gardens and the cause of death are recorded. For these animals the longest period of life in the Gardens was ten years and ten months, the shortest three days. The average for the group was slightly less than two years. Given as causes of death are: ulcers of the tongue, bronchial pneumonia, acute bronchitis, tuberculosis, typhoid fever, peritonitis, hypertrophied liver, debility (probably anemia), colitis, chronic arthritis, trauma, and fracture of the skull. (Sonntag, 1923, pp. 418-419.)

In a semi-popular consideration of the subject, Heck (1922, pp. 676-677) refers particularly to a disease of the skin, symptoms of which are dryness and loss of hair, diseases of the bones, of the gums and teeth, inflammation of the intestines, anemia, tuberculosis, and intestinal parasites. It may be remarked that in general the diseases commonly referred to as appearing in captive chimpanzees are such as are traceable to infection, improper or inadequate diet, and insufficient or otherwise unsatisfactory supply of water, fresh air, and sunlight.

The practical experience of Sokolowsky (1908, p. 56) in the main confirms the statements of Heck. The animals by Sokolowsky are characterized as peculiarly sensitive to drafts and liable to colds, inflammation of the lungs, intestinal diseases, and dry, scaly condition of the skin which demands frequent treatment with oils and warm baths in soapy water.

The experience of the several anthropoid laboratories and observation stations is little in point because relatively few specimens have been kept and still fewer lost by disease or accident. Nevertheless, certain statements may be taken with profit from reports emanating from these establishments.

In the Kindia Station of the Pasteur Institute, chimpanzees, and presumably also other primates, are being used for experimental studies of tuberculosis, with intent to develop a serum which will immunize human beings. It is further stated (Honoré, 1927, p. 409) that in the Paris laboratories of the Pasteur Institute various primates are being used to promote studies of infantile paralysis, encephalitis lethargica, and cancer. The Director of the Institute, Calmette, referring specifically to the chimpanzee, which is used for the study of various medical problems in the Kindia Station, has made the following significant statement:

> It seems that all microbic maladies of the human race can be transmitted to chimpanzees, and that many of them are transmissible to the lower apes. This is true for syphilis, typhoid fever, cholera, bacillic and amoebic dysenteries, exanthematous and recurrent typhus, yellow fever, pestilence, acute poliomyelitis, measles, scarlet fever, smallpox, trachoma, pneumonia, grippe. It is equally true for maladies produced by protozoa or by parasites: trypanosomiasis, leishmaniosis, bilharziosis. (Calmette, 1924, pp. 18-19.)

Numerous studies of parasites of the blood and intestines of the chimpanzee have been made. Malaria occurs in it as in man, but there appear to be uncertainties about transfer. Important references to these special studies are Reichenow (1917), Mesnil and Roubaud (1917), Blacklock and Adler (1922), and Adler (1923).

Adler and Clark (1923) described, with particular emphasis on resemblance of the

course of the disease to that in the human subject, a case of acute ascending paralysis.

Of considerable value are the experiences of Rosalia Abreu with her large colony of captive primates at Havana, Cuba. A brief report on the pathology of the colony, with indication of prevalent diseases and modes of treatment, is to be found in Yerkes' general description of the Abreu experiment (1925, pp. 235 ff.).

With reasonable assurance it may be said that the chimpanzee far more closely than other animals, with the possible exception of the orang-outan and gorilla, resembles man in its pathology. It is subject to many diseases which are prevalent in man, and it differs so radically in this respect from the other mammalia that for its treatment a physician instead of a veterinarian is indicated.

Disabilities as contrasted with diseases are relatively rare, it would appear, in nature as well as in captivity, for the animals are dexterous as well as agile, sure of grasp, and unlikely to injure themselves in the handling of dangerous objects. Few indeed are the reports of disabilities resulting from falls, cuts, bruises, bites, or similar misadventures, as compared with the record for man. Presumably such accidents tend to increase with age, yet of this there is little evidence. Again we take a page from the history of the Abreu colony.

> Injuries and diseases must be faced by any one who undertakes to keep monkeys or apes. Although many of them bear close resemblance to our own physical difficulties, there are significant differences which it is useful to know about.
>
> To begin with injuries, it is rarely indeed that they are self-inflicted, or that by untoward accident, in handling or playing with objects or in running about or climbing, the animals come to harm. Occasionally they cut themselves in improperly constructed cages, but more often they are hurt either in play or in serious attack by companions or other animals. Such injuries usually are trivial and readily treated. The only precautions exercised at Quinta Palatino, and they are wholly approved by the experience of the writer, are cleanliness and the application of some bad-tasting or ill-smelling antiseptic preparation which is at once useful to keep the wound free from dirt and to prevent the animal or its companions from disturbing it. Broken bones, Madam Abreu says, are rare in her experience and are almost always the result of fighting. Except in the case of dire necessity, bandaging is undesirable, first because unnecessary, and second because the animal, unless constantly watched, may do more harm in its attempts to remove the bandage than would result from leaving the wound open. Severe cuts and broken bones should be treated with the technique of human surgery. The use of local anæsthetics Madam Abreu approves, but she strongly advises against chloroform and ether as general anæsthetics. (Yerkes, 1925, pp. 234-235.)

Von Oertzen (1913, pp. 17-18) reports two cases of accident which we believe indicate important physical characteristics of the animal. The one is of a young chimpanzee with broken arm. The fracture in fourteen days was completely healed and the arm ready for use. Another specimen, supposedly about eight years old, after falling some fifty meters from a tree, turning over and over in the air and landing with a crash, jumped up and went about its business with no other evidence of disturbance than a bleeding nose.

Behavior during illness, and especially the attitude of the chimpanzee toward human attendants, is of very great psychological interest and importance. We believe that certain psychobiological characteristics of the animal are well exhibited by an exceptionally interesting detailed account of the habits and illness of a specimen estimated to be fifteen months old, which early in the last century was exhibited in the London Zoölogical Gardens. This extraordinarily illuminating report we owe to one Youatt, a physician.

> On the following day he was quite well, and so he continued until February the 27th, when his appetite failed; he was restless; he had an anxious countenance; and his paw when he gave it to me, for by this time he and I were sworn friends, was hot. There was no apparent local affection. He was feverish. I ordered two drachms of the sirup of buckthorn to be given in his tea. Several medical gentlemen afterwards met me in consultation. Pallidness was stealing over his dark face; his ears were lividly pale, and his countenance expressed much anxiety and debility. He would play a little when we coaxed him, but he was becoming irritable. Another dose of the buckthorn was ordered 29th. The symptoms had increased; his

medicine has not produced the desired effect. Double the quantity.

March 1st. He must be coaxed to take the least particle of food. His bowels are not yet thoroughly opened. Give two grains of calomel at noon, and two drachms of the buckthorn at night. [March] 2nd. The medicine has operated well, and the feces were exceedingly offensive. A little better. He ate an apple, but he is continually coaxing to be nursed.

[March] 3d. More disinclination for food. A surgeon joined me in consultation. It seemed to us to be a case of infantile fever, without any local determination. Two grains of the white antimonial powder morning and night.

. . . .

[March] 6th. Apparent improvement. The pulse has fallen to 96; but his temper is changed, and he is rapidly wasting. Yesterday as soon as I entered the room he stripped up his sleeve, showed me the puncture of the lancet, and scolded at me; and when I offered him my hand, he tried to draw it through the bars in order to punish me. He did the same to-day, but after much coaxing we again were friends. The bowels are confined. Give two grains of calomel, and, two hours afterwards, two drachms of the buckthorn.

[March] 7th. The medicine operated well, and he is better. He again showed me the mark of the lancet, but he immediately afterwards offered me his hand, and intimated that he forgave me. Another surgeon of repute saw him, and pronounced it to be a case of *teething:* but I could not find the slightest enlargement, or heat, or tenderness of the gums. This gentleman did not approve of the calomel; it was therefore discontinued, but the antimonial powder was given as before.

[March] 8th. He scarcely touches milk; he will not eat, and, altogether, he is worse. The bowels not acting, I once more gave him his calomel, and the antimonial at night.

[March] 9th. The calomel has caused the evacuation of a load of pultaceous feces . . . ; but he is very low and dull. A surgeon who had previously seen him, again met me in consultation. We fancied that we felt a slight enlargement now of the posterior part of the upper gum on the right side; and there not being, even to the present moment, *the slightest indication of any other local affection,* except that I fancied that his head felt a little hot, we determined to treat it as a case of teething. The gums, above and below, and on both sides, were deeply lanced, and on the right side of the upper jaw I did cut down on a tooth. Give him half a drachm of calcined magnesia in the morning, and two grains of antimonial powder at night.

[March] 10th. A great change has taken place since last night. The pallid look has returned, with an increased pitiable expression of the countenance. The strength is altogether gone. He will not sit up above a minute at a time. He would not drink the milk in which his magnesia was put, and therefore it was forced upon him; and now he is suspicious of every body, and will not touch the slightest portion of food. Try the magnesia once more in a little tea, but never again drug his milk. He will not touch his tea; then force the medicine upon him, and give him two grains of ginger in each dose of the magnesia. After the first dose he had a copious, but, for the first time, a mucous discharge per anum, and tinged with blood, and then he appeared to be sadly depressed. P.M. A little revived. The feces are now almost the colour of bile, with flocculi of coagulated milk. Give to-night half a drachm of calcined magnesia, with the same quantity of the sirup of white poppies.

. . . .

[March] 14th. Better. He recognises me the moment I enter the room; he climbs his tree when bid; feces natural, but his pulse still 120. He is fond of his asses' milk. Continue treatment.

[March] 15th. Much improved. He recognises every old friend with his usual chuckle, and has eaten a little bread and butter. Give him as much asses' milk as he likes. One of the surgeons recommended small doses (five minims) of the liquor potassæ in his milk, with a little ginger. I pleaded for a holiday for him, at least for one day.

[March] 16th. Going on satisfactorily. He will not eat, but drinks plenty of milk. He is to have his potash to-day, which sadly disagreed with him. He vomited twenty times, with a few streaks of blood. The feces were likewise tinged with blood. Give three times daily half a scruple of prepared chalk, with two grains of ginger, and two drops of the "black drop."

[March] 18th. The sickness and purging have ceased, and the poor fellow is a little more lively, and takes milk both of the cow and the ass. Continue medicine.—[March] 19th. Drinks his milk with appetite, notices every one about him, and is better tempered; but he refuses the choicest fruits, and touches nothing solid. *He also coughs.* I would rather anything than this. Rest awhile.

. . . .

[March] 21st. The disease has essentially changed its character. I can hear him breathe at a considerable distance, and the cough is more frequent and painful. His pulse is 150, and he is sadly weak. He is half unconscious, except that on being touched, or even looked at, he breaks into fretfulness and screaming. We put him into a warm-bath, but he struggled and screamed, and was speedily taken out. Feces natural. Give him half-drop doses of the "black drop," with two grains of ginger, three times every day. Dilute his milk, and offer it to him more frequently.

[March] 22d. Does not breathe so laboriously, nor cough so frequently or painfully, and the pulse is 140, but as weak and thready as ever; he is, however, still more lost to surrounding objects. My valued medical friend met me at the gardens. We both thought that the only chance of success lay in rousing the animal power by some mild stimulant, and we determined to give him a couple of drachms of ginger tea three times in the day, coaxing him to take diluted milk frequently. In the evening he seemed better, but though he brightened up for a moment or two, his eyes speedily closed, and he looked as if he were dying.—[March] 23d. He seems a little better. In the evening he climbed up his tree of his own accord. Continue the ginger tea.

[March] 24th. Cheerful; evident appetite; but his countenance still more pallid. In the afternoon there was a sad change. The face was *blanched;* eyes sunk and almost closed; the lower lip fell, and he scarcely noticed any one. His milk, however, he would slowly sip when put to his mouth, a tablespoonful at a time. His pulse felt with the greatest difficulty, and it fluttered most singularly. His feces begin to pass involuntarily. Double the stomachic.

[March] 25th. Hope has now quite fled. The only notice which he takes even of his old nurse, who loved him almost as if he were her child, was to slowly open his eyes, and gaze piteously for a moment on her or his keeper; then the lid drooped, and a feeble breathing and a faint moan were the only indications of life.

At eleven o'clock at night he all at once roused himself, and began to scream violently. He was wrapped in a blanket, and held on the lap of his keeper, to whom he clung closely, frequently feebly raising his head and gazing piteously on his face, during about an hour, when the screams lessened, and assumed a painful resemblance to the cries of a sinking infant. By two o'clock, on the following morning, they had gradually subsided. He then attempted to free himself from the blanket, which, with assistance, he accomplished; then with an effort, of which a moment before he seemed to be incapable, he flung his arms around the keeper's neck, clenched his hands for firmer hold, threw back his head a little, brought it before that of the keeper, gazed intensely on his face, with a remarkable expression, so continued for one or two minutes, gradually loosened his hold, let fall his arms, and died without a struggle.

He was examined on the following day. I could not be present, but Mr. Martin favoured me with an account of the post-mortem appearances. "The death resulted from great visceral disease. The spleen was tuberculated, and united to the adjacent viscera by strong adhesions. The lower portion of the ileum was extensively ulcerated, and in several places the coats of the intestines were completely destroyed, and, had it not been for extensive adhesions at this part, the contents of the bowels must have escaped into the abdominal cavity. The cæcum also participated in the disease. The mesenteric glands were morbidly enlarged, and the liver was diseased, its colour being of a grayish yellow, exhibiting the minute portal vessels gorged with blood. The lungs were tolerably healthy, but the substance somewhat firmer than in their natural state. They may be said to have been hepatized in a slight degree; they were, however, unobstructed. Dentition had nothing at all to do with the affair." (Youatt, 1835-36, pp. 204-206.)

The literature contains many interesting and useful accounts of the behavior of sick chimpanzees. All agree in indicating a child-like attitude of dependence and trust in human attendants. These statements of course apply primarily to immature animals. It is relatively difficult to deal with the adult, but it also becomes amenable to medical or surgical attention, and at times, as we shall now attempt to show by citation of authorities, highly coöperative.

Nothing perhaps is more highly indicative of the resemblance of this ape to man in mental constitution than its attitude toward man when it is in trouble. There is not only a sense of dependence but a degree of subordination and desire to coöperate which are truly astonishing.

Quoting one Doctor Martini, Heck reports behavior during an operation.

"After consultation with a colleague, an opening into the tissues by an incision at the top of the larynx was recognized as practically necessary. This advice was easily obtained, but the kind and manner of its execution were difficult. Each movement of the suffering animal during the difficult operation might give the knife a fatal or at least a harmful direction. Anesthetizing with chloroform was in consequence of the serious condition of the lungs forbidden. Chloral-hydrate used tentatively in a dose of three grams scarcely caused a half sleep but not unconsciousness. After three hours of unsuccessful waiting we finally went at the work. Four men held the animal in vain. Exercising all his strength the chimpanzee shoved the people to one side and did not cease to rave until the ominous people had been shown to the door. What could not be obtained by force was now to our astonishment freely accorded. Quieted again by soothing words and caresses, the suffering animal, without opposition, allowed a thorough investi-

gation of the swelling of the neck and even invited my hand to make it by his pleading look. This suggested to us that we might dare the operation without the help of anesthetics and without any bonds. Sitting upon his keeper's lap the ape bent his head backwards and willingly kept it in this position. The necessary cut was rapidly made, the animal neither shrank nor gave any sound of pain." (Heck, 1922, p. 669.)

Wholly consistent with the observations of Heck are those of Terrier (1903, p. 414) who in performing dental operations on a trained chimpanzee named "Consul" decided to try to win the confidence of the animal instead of having it forcibly held during dental treatment. He reports that his method was remarkably successful, for he so far won over his subject that it would quietly and without restraint permit him to fill decayed teeth and perform extractions. The animal is reported as approximately four and one-half years old. Apparently this is an excellent instance of confidence and coöperation with insight. Looking farther back in the literature of the subject we cite Warwick (1832) as testifying to the ready coöperation of a sick chimpanzee when bleeding and blistering were necessary. So common are reports of this sort that we may not cite them exhaustively. Instead we shall conclude our presentation of evidence with certain original observations.

While the writer was studying Madam Abreu's primates, a blood-transfusion operation was performed in an attempt to save the life of one of the chimpanzees. As a preliminary to the operation the blood of several of the adolescent chimpanzees was examined to enable the physician to select as the "donor" an animal whose blood was of the same type as that of the invalid. The several animals behaved quite differently in the operation. Some struggled violently when the sample of blood was taken from the arm; others seemed to understand that no harm was to be done them and coöperated as might a person. When it came to the transfusion operation itself the sick chimpanzee was too weak and listless to struggle, but the animal whose blood was to be borrowed was a healthy, vigorous creature whom one might naturally have expected to rebel against the treatment of the surgeons. Instead she lent her aid to them and remained virtually quiet throughout the operation. The physicians themselves were so impressed by her coöperation that they expressed keen regret in not having secured a moving-picture record of the operation which should show in detail the behavior of both of the chimpanzees involved.

The writer can match these instances of chimpanzee coöperation with human attendants or helpers from his own experience with a pair of young chimpanzees which needed medical attention. The treatment required was for hookworm and each of two animals, a male and a female, was handled and treated in the same manner and with as little disturbance and discomfort as possible. The little male, having suffered his jaws to be wedged apart and a stomach tube inserted, became quiescent and acted throughout the treatment as though he implicitly trusted the wisdom and good intentions of his human attendants. The female, on the contrary, resisted the treatment at every stage and continued to struggle to the end. Was hers lack of confidence or lack of understanding? From the above description it might be assumed that the male was meek and lacking in initiative by comparison with the female, but as a fact the opposite was true; and apart from difference in intelligence any one intimately acquainted with the two animals might naturally have predicted that the male would resist to the limit of his strength and the female yield coöperatively to the demands of the physician.

Evidences such as have been presented might be multiplied almost indefinitely from the experience of Madam Abreu and her assistants and from the observations which the writer has himself made or has found in the records of reliable investigators, but there is no point in doing so. It will serve better in extending and refining our knowledge of primate intelligence to consider other aspects of behavior and other relations of the animals to man. (Yerkes, 1925, pp. 80-82.)

Accurate measurements of body temperature, pulse, and respiration, their variations and characteristics in the chimpanzee, are not available. The following authorities, however, may profitably be consulted: Keith (1896), Sonntag (1923, 1924), Fox (1923), Calmette (1924).

CARE IN CAPTIVITY

Practical aspects of care in captivity might readily be discussed at length, for ample information is afforded by the literature. Briefly we may comment on three important phases of the care of captive chimpanzees: cleanliness, shelter, and nutriment.

A hygienic environment is absolutely es-

sential. The animals naturally must have adequate space and facilities for personal cleanliness, and their quarters must likewise be maintained in hygienic condition. Thus only may they be expected to live normally, healthfully, and free from parasites.

The long prevalent superstition that tropical animals require high temperatures has finally been destroyed, and it is now very generally admitted that a chimpanzee, for example, readily adapts to very considerable variations in temperature and may be kept as readily and as healthfully in temperate as in torrid climates. Requisite are, as in case of man, shelters to protect from drafts, rain or snow, direct sunlight, and sudden changes in temperature. Given such protecting shelters to which the animal may retreat in case of need and in order to avoid chilling, an open-air life even in the temperate zone is demonstrably desirable. Shelter should, of course, include reasonable protection from human infection. Naturally suggested as arrangement for living quarters is a sleeping room which may be kept at sixty to seventy degrees Fahrenheit, and which communicates with a sunlit fresh-air room to which the animal may at any time gain access. If to supplement the latter an open-air cage of considerable dimensions is available, the conditions of captivity are so much the more favorable.

Nutrition presents very similar problems in chimpanzee and man. Each requires what is technically described as a balanced ration. This may be provided either on the basis of scientific guidance or by the use of a very considerable variety of foods and the effort thus to provide in adequate amounts all nutritional elements essential to healthful life, growth, and reproduction. Naturally the scientific procedure commends itself the more highly, for at best the other is hit or miss, and even with the best of intentions and seemingly wise selection of foodstuffs the keeper may fail to meet the requirements of his captive and intestinal or other disorders may develop or reproductive activities may fail.

There is no lack of useful contributions to the general subject of the care of captive chimpanzees. Especially valuable are the experiences and recommendations of directors of zoölogical gardens and of those who have been responsible for laboratory colonies. Unfortunately no single author has dealt fully and authoritatively with the subject and the best we can offer the reader is a page from the history of the Abreu colony and a list of important references.

> If, then, we were asked to sum up for the mistress of Quinta Palatino, as well as ourselves, the essentials of success in keeping and breeding the higher primates, we should emphasize the following points: freedom, or reasonably spacious quarters; fresh air and sunshine, preferably coupled with marked variations in temperature; cleanliness of surroundings as well as of the body; clean and carefully prepared food in proper variety and quantity; a sufficient and regular supply of pure water; congenial species companionship and intelligent and sympathetic human companionship, which, transcending the routine care of the animal, provides for the development of interest if not friendliness; and, finally, adequate resources and opportunity both in company and in isolation for work and play. Given these conditions of captive existence, primates originally healthful and normal should without difficulty be kept in good condition of body and mind and should naturally reproduce and successfully rear their young. (Yerkes, 1925, pp. 241-242.)

Additional suggested sources of information on care of the captive chimpanzee are: Nissle (1872), Sanyal (1892), Garner (1896), Sokolowsky (1908), Hagenbeck (1909), Mitchell, P. Chalmers (1911), Knauer (1915), Rothmann and Teuber (1915), Heck (1922), Hornaday (1922), Sheak (1923), Calmette (1924), Yerkes and Learned (1925), Honoré (1927).

CHAPTER TWENTY

SOCIAL RELATIONS OF CHIMPANZEE

THE social life of the wild free chimpanzee is very incompletely and uncertainly known, whereas there is such an abundance of miscellaneous information about the social traits and relations of captive individuals that it would be much easier to state the facts in a book than in a paragraph. In the following few pages we may not hope to do more than exhibit essential characteristics of the pattern of knowledge and define and indicate the importance of certain problems and tasks which await the ingenuity, patience, and devotion of the investigative master.

With assurance it may be stated that the chimpanzee is a highly social creature which lives in family groups or small bands and which only exceptionally, aside from senility or ostracism, lives in solitude. This is the opinion derived from observational records, but qualifications as usual are in order. Some of them we shall indicate as by sampling we review important contributions offered during the last few decades.

From Rennie (1838), Sayers (1839), and Martin (1841) we learn only of the gregariousness and sociability of this great ape. In the day of these authors there evidently was scant and uncertain knowledge of the essential social traits of the wild animal. To search still more remote records than those cited is the task of the historian. The student of anthropoid life may more profitably look forward than backward.

A new impetus to progress was given by Savage and Wyman (1843-44) when denying the applicability of the term gregarious they described, at one time, the observed tendency of the animals to go in "pairs" more often than in "gangs" (p. 384), and at another the prevalence of groups of five to ten individuals, with occasional assemblages consisting of larger numbers (p. 385). May these seemingly contradictory statements be taken as indicative of specific or local differences and does not the usage of gregariousness turn on definition? Relevant at least to the first of these questions are the data offered by Du Chaillu (1861) who agrees with Savage and Wyman in denying gregariousness in the chimpanzee, and supplements their observations by indicating that one type, the "nshiego" (*Troglodytes calvus*), goes in pairs or alone instead of in companies (p. 231); whereas another, *T. niger,* consorts in companies when young, but in maturity goes by pairs or singly (p. 358). Possibly the diversity of statement may trace rather to age than to specific or local differences.

As to definition, we would suggest that on the basis of the observations cited, the term gregarious is both applicable and inapplicable, the first in accordance with the positive definition "habitually living in flocks or herds," and the second by the more nearly negative definition, "not habitually solitary or living alone." In the latter sense evidently the animal is eminently gregarious; in the former sense, it probably is not. Thus we endeavor to reconcile the apparent disagreement of early authorities.

Complete confirmation of the statements already cited is found in Schweinfurth (1874, I, 522): "They are not found in herds, but either in pairs or even quite alone, and it is only the young which occasionally may be seen in groups." By Livingstone (1875, p. 325) it is recorded, however, that the chimpanzee lives in communities of about ten, each male having his own female; and similarly by Pechuël-Loesche (1882, p. 246) that "they live together in families and bands." Reichart (1884), citing nests as evidence, concludes

that the Sako go in herds of six to twenty. Once he observed ten nests with one fresh one, and again fifty with two or three fresh ones.

To such information as we have presented, Garner (1896, pp. 54-60) adds the following significant items. The chimpanzee is averse to solitude; the male is supreme in the family group; there may be three or four females with a single male. On occasion the animals may assemble in large numbers for a sort of "carnival," in which drumming, dancing, and vocalizing are conspicuous (see our p. 218).

Commenting briefly on these reports, we find no adequate evidence that the chimpanzee is monogamous, and we therefore suspect that Garner is correct in considering the type polygamous. Of the social institution which he names "carnival" we have discovered no other mention than Garner's.

Asserting that solitariness in the chimpanzee induces wilfulness and melancholy, Sokolowsky (1908, p. 49) refers to its life in family bands whose presence is indicated by vocalization. By the natives it is believed, according to Jenks (1911, p. 61), that although old males eventually become solitary, the young of the species on reaching maturity tend to remain in the kinship group. Obviously if this were true the family would tend to become larger than authorities thus far cited have indicated. This necessity is supported by the findings of Reichenow (1920, pp. 19-20) who, citing von Oertzen (1913, p. 16) in support of these observations, estimates the size of the chimpanzee band as twenty to thirty. The social and gregarious nature of the animal Reichenow considers established, as largely by the character and arrangement of nests as by direct observation of behavior. It appears that only mature and old males venture to build isolated nests or to place them very near the ground. Because the young for a number of years may sleep with the mother or together, the number of individuals in a band tends usually to exceed the number of nests observed.

An illuminating paragraph of recent date which at once summarizes certain legitimate conclusions and affords transition from observation of wild to captive animals, we beg to quote:

> In freedom, the growing immature chimpanzees of both sexes form the larger bands which rush through the forest with much noise, while the adult animals keep more in small family troops under the leadership of an old male who is accompanied by his wife and young sucklings. This herd drive of the young animals was shown at once by the newly arrived inmates of the anthropoid station at Tenerife. They at once formed a horde when they were let out into the large grassy garden under the leadership of the largest male, who notified all nearby human beings through his exciting or warning cries, while the larger female looking back watchfully formed a rear guard. When the animals became trustful and tame they lost this. (Heck, 1922, p. 661.)

Our account of gregariousness versus solitariness in the chimpanzee may fittingly be concluded by quotation from Buck's lively description of direct observation of the behavior of a band as it arrived at its resting place for the night and made preparations to retire. It seems that with an old male there were two mature females, one with a baby, and several immature individuals. From the author's statements one cannot be positive whether the group numbered eight or twelve individuals.

> Our way led through tangled undergrowth, along arduous paths where the liana, dropping from giant cotton-trees, held the traveler back with a solid network. At times we were forced to stop and cut a path, but finally we reached the grove. I gave each boy his place and divided the nets, leaving one long, narrow net hidden near each tree where I hoped to bag a chimpanzee and, beside it, several larger nets of the sort we threw to tangle the animal. Now all we could do was to draw the jungle over our heads and wait, under our screen of vines. Hector and I together snuggled ourselves away in a huge tree-crotch, just beyond the trees where we believed the chimpanzees would settle. It was fearfully hot. As I was about to "drop off," Hector grabbed my leg and chirped in a whisper: "Look! I told you they come. Now look yourself!"
>
> I did. It was a strange company that came filing in. An old, broad-shouldered, hairy, tawny-black male led. I strained my eyes and stretched my neck to catch every move. Behind the leader

followed two full-grown females, one with a baby. When I spied that young one, I remembered that I was a collector. I wanted that little rascal for the Philadelphia Zoological Gardens. Then I watched the others file in. There were seven or eight; I could not say exactly. They arrived like men weary with travel and immediately began to eat the greens in the grove, "falling to" without any false motions. After they had eased their first hunger, they broke into a jangling powwow, crying half in greed and half in glee. Then, again, they snapped at the red covering of the oil-palm, scooped up the wild-fig leaf and smacked their loose, whistling lips over the Christmas-tree leaf.

I should have liked to show my friends at home those chimpanzees as they reached out their long arms for their supper. No animal I have ever known eats with more gusto than the chimpanzee; in his wild state, as may be surmised, he lacks the table manners I have sometimes trained in him in captivity. The picnic continued for a long time. Now and then, when the young ones tried "to tear each other's eyes," as Dr. Isaac Watts wrote in the poem, the elders took a hand. Once a mother cuffed a pair soundly and then went back to her own supper. Once two youngsters rolled over, kicking hands and feet and spitting like devils. The leader stopped his meal long enough to end such "funny business." He seized one little codger by the shoulder, set him down hard on the ground and then turned to the other. That settled them. The old fellow's scoldings had run through the chimpanzee's vocal range, "Go, go, go," ascending through five notes of the octave. He clearly meant, "Hush up, or I'll give you something to cry for!"

Meantime I watched, fascinated. The scene was so like holding the mirror up to human nature! For, when those chimpanzees had fed, they "paired off" like folks at a church sociable. I watched the leader start up a tree with one female, while the mother ape melted into the dusk beyond my sight. The old ape took a tree fairly near me, going up first, stopping now and then for his mate. She seemed in no hurry. Perhaps she was overtired. As I watched, I thought of many men who wait for their women and who, when they are ladies' men like this old fellow, enjoy it. The female soon lodged herself on a bough below her mate, but he stretched his arms down as if to say, "Come on up. It's mighty fine here." The by-play dragged on; I imagined I caught a sly look upon her face that meant, "If I'm worth having, I'm worth coming for!" But at last, at twilight, the question was settled. Two long forearms eased down a hulking black body, and the old ape swung below. A few grunts arose from her, in crescendo and wooing, unlike her squeals down among the wild-fig leaves. As the darkness thickened, I saw him sitting with his weird old face bent over upon his forearms while his lady scratched his back. (Buck, 1927, pp. 309-310.)

On the migratory and other general activities of chimpanzee bands or family groups the literature provides almost no information. Wandering within a rather narrowly limited area in search of food and suitable shelter is occasionally mentioned, but general migratory movements have not been described (Du Chaillu, 1861, p. 231; Reichenow, 1921, p. 338). Probably it may safely be inferred that the chimpanzee rarely wanders farther than its immediate necessities demand, and that although nomadic as well as gregarious it is not migratory as are highly gregarious birds and herbivorous mammals.

On such significant features of group relationship as leadership, dominance, and subordination, additional light is thrown by recent studies of the behavior of captive groups. As especially rich in facts which supplement the information already set forth we would mention the descriptions of Rothmann and Teuber (1915) and Köhler (1917, 1921a, 1925) of the Canary Island colony; of Calmette (1924) and Honoré (1927) of the Pasteur Institute colony; of Yerkes (1925) of the Abreu colony in Havana, and of Bingham (1928) of the colony in the Primate Laboratory at Yale University.

Certain highly significant characteristics are mentioned and sometimes also briefly described in the following paragraphs which we have selected for quotation. It is impossible, unfortunately, to do justice in brief compass to the ill-digested and heterogeneous assemblage of observations on the social traits and relations of the chimpanzee which the literature now contains. Probably the best we can do for the reader by way of aid, aside from the following quotations, is to refer to what appear to be excellent sources.

We begin with Köhler's characterization of the social traits and solidarity of the chimpanzee group which he for years had opportunity to observe.

It is hardly an exaggeration to say that a chimpanzee kept in solitude is not a real chimpanzee at all. That certain special characteristic qualities of this species of animal only appear when they are in a group, is simply because the behaviour of his comrades constitutes for each separate animal the only incentive which will bring about a variety of different behaviour, and observation of many peculiarities of the chimpanzee will only be clearly *intelligible* when the behaviour and counter-behaviour of the individuals and the group are considered as a whole. (1925, p. 293.)

If an isolated chimpanzee is forcibly *attacked* before the eyes of the group, great excitement goes through the group. It will happen that, under the influence of the climate, a wrong-doer is punished with a heavy blow. The moment your hand falls on him, the whole group sets up a howl, as if with one voice. The excitement thus expressed has usually nothing of fear in it, and the group does not run away. On the contrary, if they are separated by the railings, they try to get to the place of punishment. Even the lightest form of punishment, pulling the ear of the offender, or a playful pretence at punishment, often stirred single members of the group to much more decisive action. It was, in particular, little weak Konsul, who would run up excitedly, and, in the way little chimpanzees have of expressing their wishes, with a pleading countenance, stretch out his arm to the punisher, if the ape was still being punished, try to hold one's arm tight, and finally, with exasperated gestures, start hitting out at the big man! It is from such as think it degrading to human beings to find anything human in animals, that this extraordinary assertion comes: animals never defend each other, and conduct which may look like this is produced only by the fact that the foolish creature assumes itself attacked, and in this error goes to its *own* defence. But little Konsul would come running up of his own accord, although he had been quietly squatting a considerable distance away, in order to take part in such an occurrence; and once even, when he was in another place, where he could not see what was happening, but only hear something of it, he hurried at once by a roundabout way, and fell on my arm. Unquestionably the creature "was affected" by what was happening to his companion, but it was impossible for him to assume himself in danger.

. . . .

When the apes have grown much older and their awe of us big humans has diminished, and especially after they have arrived at sex maturity, I find the drive of the group to repulse an assault on one of its members grown inordinately stronger. In the end, one has to give up punishing even bad offences, when the whole group is in the same room as the wrong-doer. At times the most insignificant episode between man and ape, which arouses a cry of anger against the enemy and springing against him, is sufficient for a wave of fury to go through the troop; from all sides they hurry to a joint attack. In the sudden transfer of the cry of fury to all the animals, whereby they seem to incite one another to ever more violent raving, there is a demonic strength, coming, surely, from the very roots of their organism. It is strange how convincing, one might say full of moral indignation, this howling of the attacking group sounds to the ears of man; the only pity is that every little misunderstanding will call it forth as much as any real assault; the whole group will get into a state of blind fury, even when the majority of its members have seen nothing of what caused the first cry, and have no notion of what it is all about. The only thing necessary to the uproar is that that scream shall be uttered in that characteristic manner that whips up all the others. It has happened to me that in such circumstances Rana, the good-tempered, has suddenly lost her head, and in a mad fury sprung at my neck, when the moment before she was playing happily with me. (1925, pp. 297-299.)

The coherence of the group is by no means homogeneous as between all the members. In Tenerife any animal that distinguished itself in any way played a special social rôle for the rest. Tschego who, as the oldest and strongest member of the group, and commanding the most respect, was the one to whom the rest ran in time of danger, and whose support each party tried to win when there was a quarrel, easily carried the whole troop with her when she changed her occupation or place. But there was Rana also who, on account of her stupidity and her dependent, unlively behaviour, was for the most part *de trop*, which state of things she did not improve by perpetually trying to approach the others; on the contrary, she only made herself the butt of all kinds of practical jokes. Secondly, there are in the relations of any two animals all grades of friendship and even qualitative colourings down to a small dislike, which apparently agree well on the whole with the pervading social union. Some of these special relations lasted all the time I made observations on the group, or as long as the animal concerned lived. Rana, rejected over and over again by the bigger animals, had taken possession of little Konsul, and never tired of him till his death. Tschego and Grande were all the time a little group in themselves within the larger group, and the friendship between Chica and Tercera lasted through all the changes of time, though it was Tercera who constituted the strong, helpful, "giving" half. In the course of everyday life, these old predilections might almost escape notice; but it only required fear or danger for them to be at once

expressed, in seeing who embraced whom, and which two retired into a corner together. And in the sharing of sleeping-apartments these proved friendships were adhered to; the younger chimpanzees prefer to sleep in couples the whole night through, with their arms around each other. In less important situations it is easy to overlook these strongly cemented relationships, because they are often overlaid by weaker and constantly changing friendships. (Köhler, 1925, pp. 310-311.)

We present these quotations from Köhler not only with implication of favor but with emphatic statement that in general our own observations of chimpanzee groups strongly support his descriptions. In one important point we should differ radically from him; namely, that the isolated chimpanzee is scarcely a chimpanzee! For our experience indicates that although removal from normal social environment profoundly modifies the life of the organism, this does not necessarily interfere with the use of the subject in psychobiological experiments or with its psychophysical growth or development. We should compare the status of the isolated chimpanzee with that of an isolated human subject. In both cases social stimuli possess great value. It may be greater possibly for the chimpanzee than for man, and certainly in both cases removal from the natural social environment is a radical procedure which may on occasion have ill effects.

In a paragraph which refers to certain species of monkey as well as to anthropoid apes, but whose statements are strictly applicable to the chimpanzee, Yerkes (1925, p. 155) briefly summarizes information concerning dominance.

Dominance and subordination are evident in every group of primates. Apparently there is no such thing as equality of status and opportunity. Leadership, mastery, control are manifest. So in their relations with persons, the monkeys and apes merely exhibit their natural aptitudes and types of social behavior. Ordinarily there is aggressive leadership in cage, colony, or family group. Domination may be by either sex, but dominance there must be, and instead of a single leader associated with individuals of relative equality, there is likely to be serial subordination. So that each individual secures in its social group the degree of opportunity for control and self-expression to which its characteristics and stage of development entitle it. Sometimes one wonders whether this type of social organization might not be valuable for man.

Attending now more particularly to social relations than to groupings, we would note, with emphasis on the adequacy of supporting observations, that as a rule tame captive chimpanzees from birth through adolescence are reasonably friendly among themselves, with man, and often also with other animals. Naturally there are notable exceptions. For adult and senile individuals no general statement may be risked. Decided preferences and also antagonisms commonly occur. A highly interesting case of the latter has been reported by Garner (1896, p. 111) who describes the growth of what ultimately became a bitter antagonism between a young chimpanzee and a negro boy who was in charge of him. The difficulty originated in a conflict of desires and resultant misunderstanding. The youth evidently lacked sufficient insight, tact, and adaptability simultaneously to dominate and command the confidence of the animal.

And so the quarrel went on until we reached the river, but by that time each of them had imbibed a hatred for the other that nothing in the future ever allayed. Neither of them ever forgot it while they were associated, and both of them evinced their aversion on all occasions. The boy gave vent to his dislike by making ugly faces at the ape, which the latter resented by screaming and trying to bite him. Aaron refused to eat any food given him by the boy, and the boy would not give him a morsel except when required to do so. At times the feud became ridiculous, and it only ended in their final separation.

Our experience affords a comparable instance in which a young male chimpanzee became and for years continued hostile toward a man whom he saw very rarely. The facts of the case are presented, under emotional expression, on page 293.

Nissle (1872, p. 205) tells of a captive chimpanzee which, when two brothers approached to play with it, often would attempt to drive the one from the cage and would then play with the other. Like evidences of marked preferences and dislikes

for persons or for other animals might be quoted from the literature or from our own experience.

Although it is well known that young captive chimpanzees are especially partial to children, and very gentle with infants or young children, caution always is in order because sudden changes of attitude are not infrequent. These doubtless are often conditioned by the behavior of the human being, but they are none the less difficult to predict and not infrequently lead to disagreeable results. That the chimpanzee is an excellent practical judge of human character and attitude, and responds adaptively as well to reliability, fairness, and justice of treatment as to observable sympathy and friendliness, is clear. An individual may not with impunity be deceived or mistreated more than once.

Favorably, and with confirmation in essentials by our own observations, we quote the following intimate glimpse of the social traits of Kearton's young chimpanzee Toto.

> To Toto, those must have been among the most fascinating days of his life. He was surrounded by friends, all eager to play with him, and he would enter into the spirit of any game, whether it was with the white children, or the black servants, or the many animals that lived in the grounds. And it was not only in games that he participated. One day, as Mr. Percival and I came out of the house, we saw a group of native "boys" sitting on the ground, washing clothes. Taking his place in the circle, accepted apparently without question as an additional helper and hard at work, sat Toto. He was entirely absorbed in his task, washing a cloth with soap in a bowl of water, wringing it out in exact imitation of the way the natives worked, then wetting it with a cupful of clean water and wringing it out again.
>
> And then there were the animals. One was a tame cheetah. These two were suspicious of one another at first, but Toto boldly "stood up" to the cheetah and tried to pat it on the nose at the first meeting; then they became friends. They would play a sort of hide-and-seek together in the long grass that covered a little hollow on the estate. The cheetah would go ahead and suddenly lie down so that it was entirely covered by the grass. Then Toto would try to find it, running here and there, and jumping into the air in his efforts to get a better view.
>
> Also there were two Airedale puppies and a rather fierce-looking hyena. Toto would ride round the garden on the hyena's back. (Kearton, 1925, pp. 80-82.)

There are many recorded instances of friendliness among captive anthropoids of different genus, but there are as well indications of initial distrust or dislike which slowly gives way before the craving for companionship. From several descriptions of social relations of chimpanzee with orang-outan in captivity we mention as examples those of Warwick (1832), Schmidt (1878, pp. 329 ff.), and Sokolowsky (1908, p. 71). The contribution of Schmidt is particularly valuable because it exhibits through description of social relations certain characteristic temperamental and intellectual traits of chimpanzee and orang-outan.

Relations of chimpanzee and gorilla in nature or in captivity are rarely mentioned. Apparently they seldom if ever meet or mingle on terms of friendly equality. Koppenfels (1877, p. 419) reports seeing a lone gorilla near a band of chimpanzees. That both types of great ape occur in the same region is affirmed by Reichenow (1920, pp. 3-4) who points out that since the chimpanzee is the more widely distributed it occurs not only in proximity to gorillas, but also where the latter are not found. And it is the conclusion of Barns (1923, p. 151) that the two types are not found in the same stretch of forest, although they may inhabit the same region. This author adds, "Their boundaries seem to be well defined, and neither animal wanders far."

It appears that when captive chimpanzees and gorillas are introduced to one another, marked evidences of timidity, dislike, or both, are manifest. Naturally, circumstances and the absolute and relative ages of the individuals are important. We have observed between an infant male gorilla and a female chimpanzee, slightly older, in the Philadelphia Zoölogical Garden, friendly companionship. But, after all, the accidental friendships which develop in captivity are of negligible value to one who would know the natural aversions, hostilities, or

other behavioral attitudes of the wild free chimpanzee.

Dreaded enemies of the chimpanzee are,

Fig. 85. Response of a young male chimpanzee to mirror image of itself. Courtesy of N. Kohts, who generously permits us to reproduce these unpublished photographs of her subject "Ioni."

we are told, leopards, serpents, and lions. The former is said to destroy many young individuals, and the terror evoked by the serpent suggests the inference that it also is dangerous. Strange large animals like horses and cattle, despite their harmlessness, are feared and avoided by immature captive chimpanzees. This presumably is caution rather than social aversion. Small animals, on the contrary, excite interest and provoke examination, which often is followed by attack and either playful mauling or destruction. The dog is a favorite playmate, but invertebrates, birds, or mammals, decidedly smaller than the ape, are more likely to be injured or killed by rough treatment than to be kept considerately.

Coöperation of captive specimens with man, once mutual confidence has been established, is frequently noted. This is equally true and more often observed within the species. Indeed, mutuality of interest and a variety of coöperation appear in the manipulation of skin, hair, wounds, or other bodily injuries and annoying conditions, of chimpanzee by chimpanzee. Likewise, concerted effort in repelling attacks or in aggression when a startling but not intimidating situation is encountered, are recounted in the literature. Instances of defenseless young and injured companions being assisted or even carried to safety are not lacking, nor, on the other hand, are cases of seeming desertion of companions when in danger or distress. No rule of behavior has been discovered, and probably none exists. With all its sociability and seeming abhorrence of isolation, the chimpanzee has a limited altruism, and only in exceptional circumstances does it manifest what looks to the human observer like unselfishness.

An extraordinary instance of coöperation by two mature captives is reported by Passemard (1927, pp. 247-248) whose description of the animals' behavior we quote on page 371.

Köhler refers to the general lack of coöperation in his colony of chimpanzees, but he also notes its occasional appearance, especially in connection with attempts to solve problems which had been arranged by the experimenter and which ordinarily of-

Fig. 86. Response of a young male chimpanzee to mirror image of itself. Courtesy of N. Kohts.

fered food as reward of success (1925, pp. 172, 177). A highly amusing bit of mutuality described by Köhler is the passing

along by one individual to another of punishment given by man for some offense (1925, p. 175). Other varied and not less

Fig. 87. Response of a young male chimpanzee to mirror image of itself. Courtesy of N. Kohts.

significant forms of coöperative behavior, or approaches to it, may be found in our own published records, in those of Köhler (1917, 1921b, 1925) and those of Sheak (1923, 1924).

The behavior of the chimpanzee toward mirror images or pictures of itself has many times been observed but seldom usefully described. Pertinent information may be found in C. P. Mitchell (1885, p. 45), Hornaday (1903, p. 1093), Köhler (1925, pp. 329 ff.). But instead of quoting we would thus summarily describe the behavior in its essential features.

In any captive chimpanzee, but especially in an isolated and, therefore, lonesome individual, the self-image commands attention and arouses interest which leads to varied investigative expressions. In a word, the novel object is treated as if it were a fellow being. It may be touched repeatedly with fingers, hands, feet, lips, cheeks, or poked, slapped, and struck gently or vigorously with hands, feet, or both. Also there may be sudden reaches behind the mirror, if such is used as source of image, in seeming endeavor to surprise the other animal and grasp it. Social interest for a time waxes as such behavior runs its course; then it wanes, and presently the image is neglected. Systematically, and for comparison, we have observed the response of chimpanzee and gorilla to the mirror image. The results are unpublished, but the description which we have given is based as largely upon our first-hand information as on what we have discovered in the literature.

Köhler, who presented to his animals not only a mirror but also pictures of the self, reports: "Each one wanted to look, and tore the wonderful object out of the other's hand." (1925, p. 329.)

Judging from the behavior of captives, fashions have their way with chimpanzees as with man. Modes come and go. Such phenomena are perpetually sources of interest to observers. Each day has its prevalent form of play or work, of social relation, or of animosity and petty quarrel. Forms of play are invented, followed intently for a time, and abandoned. Köhler (1925, pp. 71, 77, 330), who has contributed most extensively and valuably to knowledge of these forms of behavior, reports an instance of the imitative use of paint and brush in playful manner (pp. 100-101), as well as

Fig. 88. Response of a young male chimpanzee to mirror image of itself. Courtesy of N. Kohts.

numerous instances of fashions in adornment or decoration of the body of self or of companions and of surroundings.

At this point we make the natural transition to the final topic to be considered under social relations, namely, play behavior. Although the isolated chimpanzee may be active, playful, inventive, endlessly investigative, even contented and cheerful, play nevertheless is essentially a social phenomenon. From the earliest times records of young chimpanzees in captivity, and scarcely less in freedom, have included descriptions of play. The evidence supplied by such authorities as we shall mention is cumulative and on the whole confirmatory of the general statement that the immature chimpanzee in freedom or captivity is naturally very playful, the adult only slightly so, and the aged inclined rather to quiescence, irritability, and resentment of social stimulation. In the following are to be found notable contributions of fact: Rennie (1838), Martin (1841), Savage and Wyman (1843-44), Nissle (1872), Schmidt (1878), Sokolowsky (1908), von Oertzen (1913), Heck (1922), Kohts (1923), Kearton (1925), Köhler (1921b, 1921c, 1925), Yerkes (1925), Buck (1927), Bingham (1927, 1928).

Conspicuous among the playful activities which repeatedly have been described are varied fooling with objects in the environment and endless manipulation thereof; chasing, tussling, romping, mock fighting; game-like behavior, including hide-and-seek, sly tricks and surprises apparently perpetrated with mischievous intent, and finally, juvenile sexual play and practice. Inventiveness as well as imitativeness frequently are evident in playful behavior. Like the human child, the infantile or childish chimpanzee, if well and vigorous, is likely to be full of energy, good-naturedly boisterous, and eager for give-and-take social contacts.

From Köhler we extract a bit of the description of the play of a particular individual. This we have selected not only as illustrative of playful behavior, but also of variety of interest in environmental objects.

Nueva was especially ingenious. Having once discovered that it was possible to dip up water out of the butt with her little drinking-cup, she incessantly dipped and filled the cup and then poured back the water into the butt. She hardly drank it at all, but even the drops that ran down the cup were of interest to her, and she loved to dip her hand into the water and watch the rain of drops fall from it. She also used her bread—for which she did not care very much—in this water game; she dipped and soaked it and then sucked the water from it; dipped and soaked again, and so forth. She was also an indefatigable "collector." She scraped together stones, pieces of wire and wood, rags and banana skins, into heaps on the ground, into her nest, or into a tin bowl, and seemed to derive the greatest satisfaction from this procedure. None of the other animals had so developed a taste for collecting and putting objects together. Three days after her arrival in Tenerife, she split a wooden plank with her teeth and drove a wire into the gap; on the following day she was busy with a woollen rag which she tied to a stick; she was not content with simply wrapping it round the stick, but actually achieved a sort of knot, by looping one end of the rag through the portion wound round the stick and pulling it taut. However humble this effort may seem to the general public, it has an amazingly *constructive* character for anyone who knows the tearing, smashing, and demolishing tendencies of the species. Other apes than Nueva also liked to poke about with straws (or sticks) in holes and crevices, but I never observed any of them "weaving" and carefully plaiting straws through the wire interstices as she did. She had a special fancy for knots; for instance, she thrust a strip of banana leaf through a wire mesh, laboriously drew the end back through another mesh, tied the two ends together, and continued in the same way, either by slipping one end of the leaf through the knot, or tying the ends again. I often thought that she was about to begin a deliberate, though rudimentary, constructive effort, a form of manual craftsmanship, but she could never be induced to continue these efforts on any plan, however easy. When I prepared for her a wooden frame with a few loosely inserted strips of leaf, she turned aside and devoted herself to her own knots; the slightest pressure towards anything stable and "productive" extinguished her joy and interest at once, and she let the frame fall in sullen displeasure. (Köhler, 1925, pp. 323-324.)

Following certain generalizations concerning playfulness in the anthropoid apes, Yerkes (1925, pp. 86 ff.) gives a transcript from a notebook record of the playful relations of cage companions. And Bingham, from observation of the Abreu colony, says:

From the first there were observed striking differences between the social activities of the family,

on the one hand, and, on the other, those of the non-family groups. In all groups there were significant changes as acquaintance progressed between the chimpanzees and their human visitors. Among the adolescent and pre-adolescent chimpanzees a rough-and-tumble variety of play tended at first to dominate the observer's attention, but shortly there appeared less spectacular but more subtle and still more fascinating varieties of social behavior. Such changes in observations doubtless were due in part to the observer's increasing background, but the behavior of the animals was unmistakably different after they became accustomed to a foreign gallery. (Bingham, 1927, p. 78.)

Accepting speech, political relations, and use of tools as criteria, Kroeber (1928) discusses evidences of culture in the chimpanzee. Playful, destructive, and inventive he finds it to be, yet without body of social traditions.

Cultureless these higher primates are; but with reactions and faculties closely akin to our own, and manifesting at least some measure of the basal psychic ingredients which enter into culture. There is infinitely more to be learned from them by wise experiment, and no less by critical observation. We have only begun. In fact, with the wide interest in these animals, it is surprising how scant the significant scientific data on them as yet are. Further study of them is important in itself; it will be invaluable in the illumination of the basic problems of anthropology and all the social sciences; and will in turn be furthered by what it can derive from these sciences. (Kroeber, 1928, p. 341.)

With respect especially to their phylogenetic significance, certain aspects of familial relation are examined by G. S. Miller, Jr. (1928).

In concluding this brief description of the social life of the chimpanzee we would express not only dissatisfaction with our treatment of the subject, which doubtless is in part excusable because of the difficulties of coördinating facts, but also our conviction of the extraordinary importance for psychobiology of intensive naturalistic and experimental research in this field. The phenomena of chimpanzee social life are complex far beyond prevailing belief; they also are markedly and in many ways like those of man. We would even predict that experimental sociology and important new departures in social psychology may find origin in the study of the value of the social stimulus and the nature of responses thereto in the chimpanzee. If we were not able to look forward to further consideration of social phenomena in our subsequent chapters on life history, affectivity, and expressivity, we should be reluctant to conclude the present chapter.

CHAPTER TWENTY-ONE

LIFE HISTORY OF CHIMPANZEE

ONCE more, incompleteness and inaccuracy of pertinent observations enable us to make short work of what otherwise would be the formidable task of following the history of the chimpanzee from generation to generation. We shall begin the story with examination of courtship and mating, and attempt then to follow the life history of the individual from birth to death. The only systematic treatment of the subject known to us is that of Yerkes (1925, pp. 181-202), the materials of which were taken principally from the Abreu colony. The remaining literature, with a few exceptions, is constituted by informational fragments whose value often is difficult to determine.

SEXUAL BEHAVIOR

In the wild chimpanzee, courtship and mating have not been definitely described. Indeed, even the existence of courtship may not be affirmed. But captive specimens are well known to exhibit various activities which seem to have sexual significance or relations. Among them are personal adornment or decoration, rhythmic limb and body movements, forms of vocalization, and bodily contact by patting, stroking, rubbing cheeks, and kissing. Almost certainly such forms of behavior only occasionally have sexual significance, and it is possible that personal adornment should be excluded from the list.

The courtship behavior of the great apes has been observed at Quinta Palatino both when the animals are in adjoining cages and when they are together. The male chimpanzee is frequently seen to caress the female, and Madam Abreu has even seen a straw used by the male to stroke the female through the barrier of netting between them. Kissing among these animals is, like many other acts, almost human in its essentials. Possibly this is imitative. At any rate, the writer has seen no descriptions of the behavior in animals of the wild uncontaminated by human association. The sex or mating dance of the male chimpanzee has been witnessed repeatedly at Quinta Palatino. It is known that the creatures possess a sense of rhythm and a fondness for dancing. In case of the sex dance of the male the sense of rhythm is exercised and the animal also attracts attention by beating the ground with its foot and thus in a sense preparing the way for its approach. We greatly hoped to obtain pictures of the sex dance of Jimmy, but his fear of the camera frustrated every attempt. (Yerkes, 1925, pp. 187-188.)

Several times remarked by earlier writers, what we have called adornment has been somewhat more fully observed and described by Yerkes and Köhler. The individuals in which this behavior was noted by the former were adolescent females which happened to be caged together.

Both Sita and Malapulga exhibit varied forms of play and the decorative instinct. Colored fruits, such as oranges and mangoes, are from time to time crushed or split and then carefully placed on the shoulder or back and worn there until displaced by the activity of the animal. The decorative effort is unmistakable. Whether color plays any part has not been determined. The performance is necessarily crude because of the nature and scantiness of the materials available. It is nevertheless of psychological interest, and suggests, for the geneticists, problems which are worthy of careful attention. (Yerkes, 1925, pp. 66-67.)

By Köhler entirely similar behavior manifested in the Canary Island Anthropoid Station is interpreted as play, and the author does not intimate that he suspects sexual significance.

They are fond of carrying quite widely different objects about on the body in one way or another. Almost daily the animals can be seen walking about with a rope, a bit of rag, a blade of grass or a twig on their shoulders. If Tschego was given a metal chain, she would put it round her neck immediately. Bushes and brambles are often carried about in considerable quantities spread over

the whole back. In addition, string and pieces of rag are generally to be seen hanging in long strings over their shoulders to the ground from both sides of the neck. Tercera also has strings running round the back of her head and over her ears, so that they dangle down both sides of her face. If these things keep on falling down, they hold them in their teeth or squeezed under their chin, but, whichever way it may be, they must have them dangling. Sultan once got into the habit of carrying about empty preserve-tins, by taking the side that was open between his teeth. Chica, the sturdy, at one time took a fancy to carrying heavy stones about on her back; she began with four full pounds and soon reached a powerful block of lava weighing nine pounds. (Köhler, 1925, p. 95.)

Rhythmic limb and body movements, often called dancing, are frequently referred to in the behavioral literature. By Rothmann and Teuber (1915, pp. 9-10) they are described, from the Canary Island Anthropoid Station, for both sexes. The male is said to stamp or beat out his rhythm with feet, hands, or both, whereas the female tends rather to move about in circles, sometimes even whirling, the while leg and body movements are rhythmic. These authors say that the dancing of the female appears to excite the male.

In Heck are found data which both confirm and supplement the observations cited above.

In behavior a certain sex difference in chimpanzees seems to consist in that the males incline rather more to the stamping dances and clapping at the same time with the flat of the hands than do the females, especially in the older animals. In Berlin, at least, one has never seen the chimpanzee "Missie" move in dances of this kind, while in both of the large males which were to be observed there during the last decade, the earlier "Soko" and the present "Moritz," only a little stimulus, by means of a measured movement and clapping of hands, was enough to induce at once a wild dance, which for example, Klaatsch compared with the "corroboree" of the black Australians. When one adds to this the fact that not only among the so-called savages outside of Europe, but also among many European folk races, even to the Cossacks and the "Schuhplattler" [a kind of Tyrolean dance] of Upper Bavaria, to the man falls the lion's share in the dance, the whole matter is easy to understand. And also when one reads in the reports of the Anthropoid Station at Tenerife that there also a larger female danced, but quite otherwise than did the males, by a whirling around on the axis of her own body and a varied striking of the hands upon the floor. (Heck, 1922, p. 661.)

Incomparably better than any other characterization of the sex life of the chimpanzee discovered by us is that of Köhler. With this fact as justification, we quote from it at length.

I have not been able to obtain any adequate notion of the sexual behaviour of chimpanzees. As in other departments of their activities, so here: the sexual life of the Station group would have developed on somewhat different lines if even one adult male had been among them from the first. There appears, however, to be among chimpanzees nothing resembling the unrestrained and all-absorbing sexual impulse which is attributed to some species of apes. It is true that the young males—who were quite immature—became excited by meeting the adult female, Tschego, and went through movements resembling coitus with her, and at her instigation, six or eight years before they were fully adult; but certainly we cannot here speak of an uncontrollable instinct in connexion with them. It seems to me that among these creatures sexual excitement is less specific, and less differentiated from any other kind of excitement, than among human beings. We may almost say that any strong emotion, and thus also any strong external stimulus tends to react directly upon both the colon and the genitals, but not so as to give the impression of exaggerated and concentrated sexuality, but rather of an extreme vehemence and interdependence of all vivid inner processes. We may even say that this extreme frequency of sexual effects implies a certain trivialization of this sphere of life, rather than its intensity. I admit that if—from motives of hygiene—one prevents coitus among them, by segregating the sexes, one encounters developments which would not be likely in their natural condition, especially among the females in a state of need. Thus it was simply owing to our prohibition that Sultan did not at once copulate with Tschego in our presence, but in obvious collusion with Tschego and at her invitation, retired after her or led the way to a hiding-place.

The sexuality of these animals is fairly diffuse, especially in so far as there is not, either before or after puberty, any *absolute* differentiation or orientation according to sex. Often a female before the period of maturity will execute movements of an unmistakable character towards another young female; one will adopt the attitude and actions of the male. Later, when fully mature, during the very pronounced recurrent swelling of the genital organs, they press themselves against one another and perform mutual friction. No doubt this was partly owing to the lack of a

due number of adult males, but I can only repeat that even the strongest expressions of sexual behaviour gave a very naïve impression, and the drive can under its normal conditions of functioning merge constantly into the rest of the "social," or communal, life of the group. The sexuality of the chimpanzee is as it were less *sexual* than that of the civilized human being. Often when two chimpanzees meet one another, they seem to "sketch," or indicate, movements, which can hardly be classed definitely under either the category of joyous and cordial welcome, or sexual intimacy. (Köhler, 1925, pp. 313-315.)

Fig. 89. Infancy. A young male chimpanzee (*P. schweinfurthii*). Courtesy of Herbert Lang and American Museum of Natural History.

Our own observation of the sex activities of specimens in zoölogical gardens, the Abreu colony, the Yale Primate Laboratory, and in the greater freedom of life at our behavior station, Franklin, New Hampshire, enables us to confirm many of the important points made by this author and convinces us that his general and tentative interpretation of available facts is correct.

From data provided by sustained observation of the social relations of chimpanzees in the Abreu colony and in the Yale Primate Laboratory, Bingham (1928) has given a detailed description of the sexual play of immature specimens and a valuable, but necessarily incomplete, account of the mating behavior of certain adults. His is the first extensive discussion of the sexual life of the chimpanzee based upon carefully recorded observations of the behavior of certain individuals over a period of years. The document therefore stands as unique, and it is essential that the reader who is particularly interested in this phase of the life of the chimpanzee consult the original. We attempt merely to summarize this author's principal observations and conclusions in the following paragraphs.

By contrast with prevalent cross-sectional pictures of sexual and reproductive behavior in the anthropoid apes, Bingham exhibits and emphasizes the extreme importance of complete genetic description. His own contribution of fact is primarily genetic and in many ways importantly corrects and supplements existing information. The nature, relations, and relative importance of the structurally given or instinctive versus the individually acquired contribution to sexual behavior are consid-

Fig. 90. Childhood. A male chimpanzee (*P. chimpanse*) five or six years old. Courtesy of New York Zoölogical Society, E. R. Sanborn, photographer.

ered at length in the light of continuing observation of social relations in a group of chimpanzees, as is indicated by the fol-

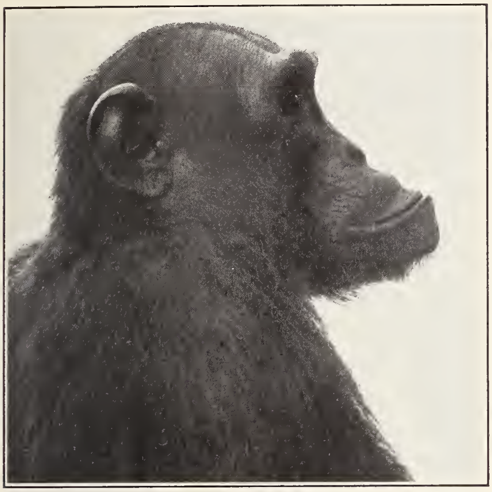


Fig. 91. Maturity. An adult male chimpanzee (*P. schweinfurthii*). Courtesy of Herbert Lang and American Museum of Natural History.

lowing quotation, and the conclusion is tentatively drawn that hereditary equipment must be supplemented by individual experience in order that sexual behavior may be perfectly adapted and efficient.

My first clue to the importance of experience in the sexual behavior of chimpanzees was revealed when Anumá and Malapulga were initially mated. Both had probably reached reproductive maturity, yet their initial attempts to copulate were failures. The overt essentials for copulation were present, but their organization was incomplete. The male seemed to proceed no farther with any of these copulatory factors than he had been observed to do previously in situations probably having for him no sexual significance. During the mating experiment, when these factors were assembled in behavior having a probable sexual focus, the female appeared much better prepared to consummate the mutual adjustments than the male. The conspicuous factors in her behavior also had been observed before she was with the male. (Bingham, 1928, p. 153.)

Observational materials indicate unexpectedly high variability in sexual expression and adjustment. Whether in chimpanzee it is greater than in monkey and less than in man is not established by observational data, but Bingham suggests probability of increase in the order: monkey, ape, man.

Copulatory play is both varied and frequent in immature animals. Homosexual, heterosexual, exhibitionistic, and masturbatory activities occur. Sexual excitement and frequency of expression are markedly increased by interspecies and extra-species social stimulation.

Serving as background and preparation for mature sexual adjustments are such social activities and relations as sucking, clinging, embracing, exploring. Eventually sexual adjustment becomes definite, but throughout the life of the organism reproductive behavior is influenced by numerous, complex, and extremely variable types of stimulation and situation. Thus, remarks the observer:

It appears that a considerable variety of stimuli may set off sexual responses in the apes and monkeys. The versatility of the chimpanzee and the variety of situations that elicit sexual behavior demonstrate the readiness with which excitations spread from non-sexual to sexual areas. There is clearly a wide variation from individual to individual in sexual adaptability. The evidence points

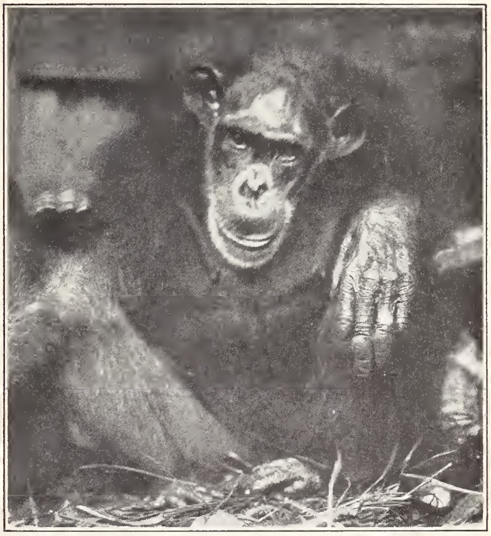


Fig. 92. Aged female chimpanzee. Said to be sixty years old. Courtesy of A. Calmette and R. Wilbert.

to the necessity of a preliminary sexual development before adequate mutual adjustments for reproduction can be made. Even in the absence of

anthropoid companions for mutual sex play, the versatility of the apes is such that varieties of sexual expression are revealed. (Bingham, 1928, p. 158.)

Naturally and appropriately the author concludes by discussion of the unique importance of the anthropoid apes as material for the experimental study of the genesis and relations of sexual behavior and for the investigation of special problems in the psychobiology of reproduction and social life. The monograph which we have thus briefly and inadequately summarized contains a useful selected bibliography.

Apart from accounts of the sexual play of immature individuals (see especially Bingham, 1928), descriptions of copulatory behavior are found, so far as we have discovered, only in Montané (1915, 1928), Sokolowsky (1923), Passemard (1927), and Fox (1929). The first obtained his information in the Abreu colony; the second, from captive groups kept in various German zoölogical gardens; Passemard, from Abreu specimens temporarily in France, and Fox, in the Philadelphia Zoölogical Garden. The sexual activities in one group Sokolowsky has thus described:

The troup consisted of a large adult male, a few younger females and a young male. The old male was even in captivity the undisputed guardian and ruler of all the other members. He kept himself aloof up at the top of the cage, seated on a board, observing and controlling the doings of the others. If a quarrel arose he sprang down from his seat, and made an end to it by blows and bites. He never indulged in games or sports, but preserved his austerity which was respected by the others. The sexual appetite of this male was very interesting to note. He was very exacting in this respect, and demanded repeated intercourse every day with his females. For this purpose he sprang down, and seized one of the females who even if she struggled at first had to yield finally to his superior strength, and submit to copulation. When he saw the young male attempt intercourse with the females, he sprang on the couple, and drove the young male off with bites and blows. The young male succeeded in effecting intercourse only when he waited until the old male was asleep, and then made advances to the females who acceded. From my observation the old male exercised his power and strength in a despotic manner, and demanded sexually implicit submission. (Sokolowsky, 1923, p. 614.)

The short article by Sokolowsky from which we have quoted gives a general account of the sexual life of the anthropoid apes. Although the author is concerned largely with morphological facts, he presents also certain behavioral data.

Of sexual and other social relations of wild individuals after mating nothing is definitely known. From the arrangement of the nests of *T. calvus* in pairs, Du Chaillu (1861, p. 359) concludes that they remain together throughout the year instead of merely during the period of mating. In doubt also is the nature of the reproductive association in the chimpanzee, for some authorities consider it monogamous and others polygamous. The observations of Garner (1896, p. 54) seem definitely to support polygamy; and, we may add, the reports of various observers indicate the presence of more than one apparently mature female with a mature male. The evidence, however, is far from being decisive, and especially since such authorities as Livingstone (1875, p. 325), Forbes (1894, II, 192), and Reichenow (1920, p. 20) either definitely accept monogamy as established or consider it probable.

By Dr. Robert Wilbert of the African Station of the Pasteur Institute, at Kindia, French Guinea, we are informed that *T. niger* generally mates during the rainy season, August to October, and gives birth to young more especially from June to September. Sexual intercourse may occur throughout the year, and births are not strictly limited to any one season.

Genetic relations of sexual behavior and social relations are examined and discussed critically, constructively, and with insight, from the vantage ground of the zoölogist, by Gerrit S. Miller, Jr. (1928), under the caption, "Some elements of sexual behavior in primates and their possible influence on the beginnings of human social development."

MENSTRUATION

THE process of menstruation or catamenia, early observed in the chimpanzee, and

emphatically denied by believers in the uniqueness of man as rendering the animal preposterously human, is an established fact. Neglecting several references of undeniable historical interest we select Keith as authority and quote an admirably succinct statement which he prepared at the close of the last century.

Little is known concerning the menstruation of the Anthropoids. The only observation is that of Ehlers [1881], of a Chimpanzee which began to menstruate about the tenth year, and continued, until it died two years later, to show a monthly discharge. Mr. Mackay's observation on "Johanna" verifies Ehlers' statement; she began to show a monthly discharge when she was believed to be ten years old. The discharge appears every 28th day, and lasts for three days. It is sanguineous in colour, profuse, amounting to perhaps 4 or 6 oz., staining freely her skirt. She is then very irritable. For 6 to 8 days before the discharge appears she is in heat, the genital labia are turgid and swollen; the nipples are fuller and more erect. When the discharge appears, the state of turgescence in the pudendal organs passes away. She shows a friendly disposition to men rather than to women. She frequently plays with her nipples, but has acquired no degenerate sexual habits. The sexual state, so far as Mr. Mackay has observed, does not change with the season of the year. (Keith, 1899, pp. 297-298.)

The fact is definitely and convincingly supported also by statements to be found in Hartmann (1885), Duckworth (1899), Montané (1915, 1928), Heck (1922), Sokolowsky (1923), Köhler (1925), Bauman (1926), and Fox (1929). Because of his exceptionally favorable opportunities for observation over a period of years, we quote the definite statements of Köhler.

The female of the species definitely menstruates, at intervals of thirty to thirty-one days, and always for a period of between three and six days. During the flow her sexual instinct is absolutely quiescent, but her temper is often particularly amiable. After the cessation of the flow, there is an access of sexual desire, accompanied by a pronounced swelling of the whole external genitalia. At this time the animals are irritable and uncertain in temper, and suffer a good deal from the very sensitive swollen area, until it subsides.

I note, in conclusion, that Grande, who was, in many respects, exceptional, always showed considerable sex indifference towards her male fellow-captives and was also "let alone" in this respect by them, although otherwise they were comrades and play-fellows. (1925, p. 315.)

The literature contains several references to changes in affective attitude seemingly correlated with catamenia. Typical statements may be found in Montané, as quoted below, Heck (1922, p. 660), von Allesch (1921a, pp. 672-673), and Bauman (1926, p. 2). Generally it has been assumed that the process does not occur during gestation, and by Abreu, as cited by Yerkes (1925, p. 189), it is believed not to occur until the offspring is weaned, but observations reported from the Philadelphia Zoölogical Garden indicate that it may occur during gestation (Fox, 1929, p. 42).

We quote as follows from Montané because of the important bearing his observations have on the common method of estimating duration of gestation.

With regard to Cucusa pregnancy was first suspected in the month of August, 1914, because, at the catamenial period, the genital turgency was moderated while there was also a decrease in the flow of blood. These symptoms were significant, as it is known that at these periods the development of the external genital parts reaches a voluminous size. During this period also, Cucusa's usual joviality disappeared; at the same time she was losing appetite, showing a certain dislike for food, which was expressed sometimes in actual vomiting. Soon there could be no doubt as to her true condition, as the mammary glands were becoming more prominent and the abdomen was showing already a sensible volume; furthermore, all signs of catamenia disappeared during the last three months of pregnancy.

This last fact definitely settles the doubt expressed by Broca [1869] in his report on the order of the Primates: "Regarding the anthropoids, the question of the catamenial flow has remained doubtful up to the present time, as there has been no occasion to study female adults in captivity." Cucusa, in her normal condition, sometimes has had very abundant losses of blood. Another fact which should be mentioned, being of interest to naturalists, is that, contrary to what is observed in the case of most mammals, sexual relations between Jimmy and Cucusa continued during the whole period of gestation, both day and night. (Montané, 1915, p. 10.)

AGE OF SEXUAL MATURITY

For neither sex is the age of sexual maturity definitely known. It is sometimes

asserted that the animal develops physically more rapidly than does man, and from this uncritically accepted statement it has been argued that sexual maturity is achieved at an earlier age. On this point, referring to individuals in the Abreu colony, Yerkes writes:

> Anumá's life has been observed from conception through birth, infancy, childhood, and adolescence, to the threshold of maturity. He now is more than ten years old and is comparable physically, we believe, with a boy of twelve to fourteen. There is no positive proof that he is sexually mature, but his behavior and what has been learned of other individuals suggest that the male chimpanzee attains sexual maturity at the age of ten to twelve years. The female of the species seemingly passes from adolescence into sexual maturity a year or two earlier, perhaps at the age of eight to ten years. Malapulga and Sita, for example,—individuals which seem to be about half-grown, weighing about fifty pounds, and aged seven to eight years as nearly as may be judged by size, weight, and condition of teeth,—are quite clearly on the threshold of sexual maturity. Malapulga is somewhat in advance, and if the two were in the wilds she almost certainly would mate earlier than Sita. (1925, pp. 194-195.)

The age of sexual maturity in the female is commonly estimated at eight to ten years, although some authorities have placed it as low as six years; and that of the male at ten to twelve years. From extended observation and access to the records of the London Zoölogical Garden, P. C. Mitchell (1912, p. 39) remarks: "It is generally assumed, however, that the duration of youth in anthropoid apes is from eight to twelve years, and the estimate is probably not very far wrong." Observational data for the female of the species are few and unsatisfactory, and for the male none are available. Heck (1922, p. 661) cites an instance of the lack of spermatozoa in a male at least eleven years old which was examined, but in this instance we may not overlook the fact that age was not definitely known. By Fox (1929, p. 41) the breeding of two individuals supposed to be under eight years of age is reported.

Certain reasons for these informational lacks are apparent, and it is clear also that definite knowledge awaits the establishment of suitable anthropoid breeding station in connection with which studies of the cycles of oestrus and gestation may be conducted under experimentally controlled conditions.

Our tentative conclusion, after critical examination of all available information, is that the chimpanzee matures sexually slightly more rapidly than does man in the tropics.

There are unauthenticated rumors, and even dogmatic assertions, that the chimpanzee can be successfully crossbred with the gorilla and also with man. Facts which would justify such a statement have not come to our attention; we therefore doubt its truth.

GESTATION, BIRTH, AND INFANCY

The period of gestation is commonly thought to be either seven or nine months, and although it must be granted that the evidences are inconclusive, the probability seems strongly in favor of the latter estimate. There are few observations worthy of mention. Such as we have found we shall cite. From the Zoölogical Garden of Berlin, von Allesch reports, of an observed pregnancy and birth, that there is choice between a five-month period of gestation and the possibility that menstruation continues during early pregnancy, as sometimes in man (1921a, p. 672). Our earlier quotation from Montané offers what is probably the correct answer to von Allesch; namely, that menstruation either occasionally or regularly occurs during early pregnancy, and that in consequence cessation may not be taken to mark the beginning of pregnancy. The paragraphs which we are about to quote supply, from the Abreu colony, data which we believe tentatively establish the gestational period of the chimpanzee as nine months.

> Madam Abreu has had three opportunities to observe the fruitful mating of chimpanzees, behavior during the period of gestation, and the birth and early days of the young. The first of these opportunities appeared in the relations of Jimmy and Cucusa and the resulting baby Anumá; the

second in the relations of Jimmy with Cucusa and the birth in France during the war of an unnamed infant which survived for only a few weeks; and

Fig. 93. Maternity. The female chimpanzee Cucusa, with her infant son Anumá. This photograph was made for Mrs. Abreu shortly after the birth of Anumá in Havana, 1915. Courtesy of Mrs. R. Abreu and the Century Company.

the third, the relations of Jimmy and Monona with the resulting offspring, Lita.

For the first of these series of events we have the record of professional scientific observers to supplement that of Madam Abreu. Dr. Louis Montané read before the Cuban Society of Natural History, in 1915, a paper on "A Cuban Chimpanzee" in which he describes the birth and early days of Anumá. Relative to the pregnancy of Cucusa and the period of gestation, Montané says, "Pregnancy was first suspected in August, 1914, because of the appearance and behavior of the female. Finally, nine months after the first visible symptoms Anumá was born." This event established the duration of gestation in the chimpanzee. Madam Abreu confirms Montané's statements and asserts that they are confirmed also by her later observations in connection with the development of the baby born in France and Lita. It seems reasonably certain, then, that in the case of the chimpanzee the period of prenatal development is virtually the same as in man.

During this period the relations of the male and female continue as usual, but following the birth of the young and until the baby is weaned and the production of milk ceases, there is no relation whatever between the animals. It appears, then—and this is Madam Abreu's conclusion—that the condition of lactation determines the relations of the sexes. Montané, referring to this matter, states that in Cucusa lactation began on the second day after the birth of Anumá and that "sixteen days after birth there was a normal return of catamenia but without external genital turgency." Seemingly in flat contradiction of this, Madam Abreu maintains that catamenia does not reappear for several months; indeed, is not resumed until the infant has been weaned. In the case of Anumá this occurred after about eighteen months; in that of Lita after about twenty months.

For its bearing on this conflict of statements, the writer may say that during his stay in Havana in the summer of 1924, when Jimmy, Monona, and Lita were caged together, Monona at no time gave evidence of catamenia or of sex interest or relations with Jimmy. Lita, although not entirely dependent on her mother for nourishment, was still treated by Monona as though nursing. The evidence, then, seems entirely to substantiate the common statement that the female chimpanzee nurses its baby for several months, even perhaps for a year or two, and that for several years the young animal continues with its parents, constituting a partially dependent member of the growing family group. (Yerkes, 1925, pp. 188-190.)

Seemingly there are no recorded observations of parturition in the wild chimpanzee, and for captives we have knowledge of only such as are cited below. There have, it seems, been few births in captivity. We are informed either by published reports or by personal contacts of five births in the Abreu colony, of three in the New York Zoölogical Park, of one in the Zoölogical Garden of Berlin, and of one in the Philadelphia Zoölogical Garden. But only in the last instance was observation complete and adequate. Naturally difficulties are numerous and may not readily be overcome.

We present chronologically the cases which are matter of record. Of the birth of the Cuban chimpanzee Anumá this is the account:

The parturition of the anthropoid ape must have taken place between five and six o'clock in the morning, as at six o'clock the young ape was first noticed, resting on the contracted legs of the mother and still joined to her by the umbilical cord. His body was completely hairless with the exception of the head, on which hair was abundant. His eyes were wide open and his gaze indicated bewilderment.

The attitude of the mother at the moment of birth escaped observation. Nevertheless, everything

Fig. 94. Infancy. A male chimpanzee, one day after birth. He was born in Philadelphia, October 1, 1928. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

has led us to believe that the obstetric posture of Cucusa was a crouching position, as is the case among other apes. Moreover it appears that this was the true position adopted in remote times by women of the human races. (Montané, 1915, p. 11.)

Of the only living birth (two fetuses were stillborn) occurring in the New York Zoölogical Park it is reported:

On July 14, 1920, about 10.45 A.M., while passing through the Primate House, Keeper Palmer reported that the chimpanzee Suzette had not eaten her breakfast, and upon going to the outside cage to examine her, we found her lying on her back, where she had apparently just a moment before given birth to a baby. The baby was lying on the mother's abdomen, face downward and covered by the hands of the mother. Because of the fact that the event occurred several weeks before it was expected, no one was present at the critical moment save Boma, the father.

Boma had been with Suzette in the outside cage for about an hour and when I found him he was sitting, apparently unconcerned, about twenty feet from Suzette. (Blair, 1920, p. 106.)

For the Berlin case von Allesch thus describes the final stages of gestation and parturition. Menstruation having ceased in October, no change in the appearance of the female was noted until the end of January.

She ate well; there were no signs of digestive troubles; she was lively and skillful in gymnastics, and she was always friendly, confiding, and as usual grateful. At the end of January a change began to appear. She constantly became heavier, more careful in bodily movements, quieter, and exercised less and less. The abdomen swelled, but the thorax and breasts did not. The last two weeks of March she was isolated at night, but during the day she remained with the other animals, and although subdued in her movements, she took part in the common life of the group.

During the birth itself only the keeper, August Liebetreu, was present. He reported what he saw shortly thereafter to the Director of the Zoölogical Gardens, Ludwig Heck, who wrote out the official report. This report says:

"At half past four in the afternoon she was ready to go into the sleeping cage. After being locked in, she at once made a nest down below (formerly she had slept above), kept stirring up the nest and was very restless.

"At 5.20 the others sat inquisitively at the partition netting. She lay, clutching the netting with her hind feet, turned toward the exhibition room. Liebetreu noticed that she took something away

Fig. 95. Bottle fed! The Philadelphia infant was reared thus. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

from between her hind legs. With sounds of joy (oft repeated U) she laid it on her belly and covered it with straw. After a short time she lifted it again and stuck the tiny head of the small animal in her mouth. The youngster never moved. She seemed to suck the head. Then she licked it dry. But it scarcely moved. She threw it back and forth in the region of the abdomen with her hands and shook it as if in that way she would make it come to life. The keeper was afraid that the youngster was born dead. At quarter to six, however, he noticed that it breathed and lived. Loca ate the inner part of the placenta, the rest of which, together with the umbilical cord, was found the next day in the straw. At six o'clock dried fruit and potatoes were brought her, which she ate lying down. She also drank freely from a pitcher of water. At evening it was noticed that the little one lay on her breast. Loca greeted the keeper in friendly fashion. A blanket which was handed her she took, although the preceding days she had scorned it." (Von Allesch, 1921a, pp. 673-674.)

To a pair of young chimpanzees, cagemates in the Philadelphia Zoölogical Garden, an infant was born October 1, 1928, according to the report of Fox, who under uniquely favorable circumstances observed parturition and behavior of mother and infant thereafter.

The estimated age of the parents is seven to eight years. They were kept together throughout the period of pregnancy and separated only when warnings of parturition were observed. During the gestational interval sexual intercourse continued, as also menstruation. The latter, however, was irregular. (Fox, 1929, p. 42.)

There follows circumstantial account of birth as prepared by Fox from notes written immediately after the occurrence.

On October 1, when first seen by the writer early in the forenoon, nothing was noted out of the usual. Breakfast was eaten. At about 9.00 A.M., the keeper heard a deep, sighing yawn, repeated several times. (This, the writer surmises was the pain of the first stage of labor, which, if true, would indicate that labor began about 9.00 A.M., and finished at 11.25 A.M.—two hours and twenty-five minutes.) About 10.00 A.M., McCrossen [keeper] noted the usual chimpanzee howl, which, according to him, seemed to have what the observer would interpret as alarm and possibly pain. The vulvar region did not attract McCrossen's attention at that time. About 11.00 A.M., he observed that there was a definite prominence of the whole posterior region and very shortly the aperture of the vulva opened and something black was observed. The writer was called and saw the animal about 11.15 A.M., when it was evident that delivery was in progress. Consultation with Mr. Dill and Mr. McCrossen as to the wisdom of trying to get "Marianne" into the den inside, resulted in a decision that it was impossible to do this, and that we would have to make her as comfortable as possible in the outside cage. Her companion, "Sultan," was coaxed into the inside cage and the intervening door barred. When first seen, she was evidently in distress and confused. Her expression was blank or that of bewilderment. She moved around the cage, up on the box, up on the side bars and cross bars, all the while putting her hand on the presenting perineum and licking the drops of fluid that she could obtain. McCrossen reports that he saw no sudden gush of fluid. The drops that hung from the vulva were cloudy but quite limpid. The writer was apprehensive lest she drop the young from the top of the box or bars, and he had McCrossen put a large quantity of hay into the cage. She moved down into the hay and seemed quiet for a minute, when her mate, "Sultan," set up a racket, startling her. By reason of this, although perhaps coincidentally, the head popped out. It apparently came out with the sagittal suture in the midline, occiput posterior, but almost at once the face rotated to the left. While the top of the scalp was presenting, she plucked the hairs from it and ate them. After the head was delivered she continued plucking the hairs, and with her hand wiping off the moisture which she licked also. In one minute she began tugging at the head and putting her fingers into

the mouth of the young to pull it. The cord was once completely around the neck. The eyes were shut and there was no attempt to breathe. Again suddenly the mate set up a scream, in which she joined and jumped to the top of the box with one leap. The body of the fetus was expelled with great rapidity and fell to the straw two feet below. She paused a few seconds, felt of her perineum and then approached the baby and smelled, all the while licking her lips. The baby was not breathing, nor did it breathe for many seconds. She overlay it and put her mouth to its mouth. There was a distinct heaving respiration on the part of the mother, and it seemed to the writer, to Mr. Dill, and to Mr. McCrossen that she was blowing into the baby's mouth. The writer makes this statement with considerable reserve, and would not make it were it not that the act was repeated one minute later. Following the first probable artificial respiration, the baby breathed. This was perhaps one minute or one minute and a half after delivery. Then there were several seconds without respiration, when another heave was noted. Following the second "blowing" by the mother, respirations became more frequent and were perhaps ten seconds apart. During this minute or so, the mother overlay and cuddled the baby as it lay in the hay, mouthing it, licking it a little, investigating it and opening its mouth, and then later tried to open its eyes. After three or four minutes she left it and began to draw the straw up around her for a bed. A few seconds after she left it, the baby gave a wheeze and little cry, whereupon the mother rushed back to it, covered it, cuddled and mouthed it, and began what might be called kissing it. She then left it and returned to making a bed with the straw, in the midst of which she sat, ever and anon stretching out to cover, cuddle and investigate the baby.

When the baby was projected from the mother and fell to the straw the cord broke at about eight or ten inches from the body. There was no hemorrhage from the fetal end of the cord, but there was a discharge at that instant of perhaps a half ounce of blood from the vagina. As the mother leaned out from her bed to cover and cuddle the baby, she had a rather trembling respiration, sometimes heavy and sometimes very short and shallow.

The observations described required not over ten minutes, when the birth was complete, and the baby breathing regularly and rapidly with short abdominal respirations with some slight heaving of the chest. (Fox, 1929, pp. 42-44.)

Especially remarked by Fox is the affective expression of the mother. It was first bewilderment, then anxiety or pain; then, following the birth of the infant, bewilderment reappeared. Neither anger nor fear was manifest and the animal, it is said, seemed to know what to do for the infant and to feel affection for it. Observers, whether familiar or strange, caused no disturbance and their near presence to the cage was not resented by the female.

The infant at birth was clean, with mottled brown skin, much of which was covered with black hair. There were no teeth. The first cry observed was a grunt, followed by a faint shriek, but later cries are described as like those of a human infant. Although from immediately after its birth the mother attended closely to the infant and whenever it cried covered it by bending over it, she did not move it about with her hands nor attempt to lift it to her breast. Occasionally the infant, as her body touched it, grasped her hair with its hands or feet, but it did not hold with sufficient strength to cause it to be lifted when the mother changed position.

On October 3, since the mother had not lifted the infant and there was no indication of nursing, attempt was made by the keeper to feed the baby artificially, but when the nipple of the milk bottle was placed in its mouth it failed to suck and it was necessary to drop the milk into the mouth in order to force swallowing. "In view of the fact that there has been no sucking reflex, it was decided to remove the baby from the mother and take it to the laboratory" (p. 46). This was done some forty-eight hours after birth, and in accordance with the following description the baby was nourished on a mixture of one part evaporated milk and six parts water.

When received at the laboratory at 11.30 A.M., October 3, the infant was cold. Artificial heat was applied and it was given small quantities of milk. The weight at this time was 1,720 grams. During the first feeding the animal did not suck, but instead swallowed involuntarily as the milk flowed into the throat. At 5.30 P.M. the body temperature was 97.6; at 8.00 P.M., 98.8; at 11.00 P.M., 99.6; at 3.00 A.M., October 4, 97.8; at 7.00 A.M., 97.8. During the twenty-four-hour interval from 7.00 A.M.,

Fig. 96. The Philadelphia chimpanzee of fig. 94, photographed when six weeks old. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

October 4, to the same hour October 5, a total of five ounces of diluted milk, half ounce at a feeding, was taken. It was not swallowed readily during the night, but "when the 5.00 A.M. feeding was about completed, he suddenly began searching with his mouth as though for the breast. The rubber nipple was quickly placed in his mouth and he immediately began to suck vigorously. This sucking reflex remained, steadily growing stronger." (Fox, 1929, p. 47.)

When one week of age the infant was taking from ten to twelve ounces of diluted milk each twenty-four hours. It seemed bright, slept well, and was active. The skin appeared darker than at birth; the ears lay flat against the head.

He sucked vigorously at his rubber nipple, his fingers, coverings, or anything within reach, frequently biting quite strongly with his gums. He could hold his head up with apparent ease, and

Fig. 97. The Philadelphia infant when seven weeks old. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

had a strong grip in both hands and feet. When aroused by hunger or pain, he could pull himself half-way to a sitting position. He does not seem able to focus his vision, but is very sensitive to noises near him, and to touch. When a few hours short of a week old, he grasped the forefinger of the nurse with his right hand and held on with a firm grip while he was lifted clear out of the bed, and held there for one-half minute. His arm was flexed. He did not let go, but was lowered lest his grip weaken. His weight on this day, October 8, was 1650 grams. (Fox, 1929, p. 48.)

At four months of age this bottle-fed infant was reported as in perfect health. (*Bull. Zoöl. Soc.*, Phila., III, No. 5.)

As references supplementary in some respects to the accounts of gestation and parturition already cited we would here mention those of Yerkes (1925) and Bingham (1927 and 1928).

No mention has been found of multiple births in the chimpanzee, and it may therefore be assumed that single birth is the rule, and further that probably even twinning is rare. Whether in this respect the chimpanzee differs significantly from man we may not say.

Of psychobiological aspects of parturition and relations of mother and newborn infant, von Allesch offers an account which is at once fairly inclusive and based on direct observation. Because of the exceptional importance and also the unusualness of the information which he provides, we shall attempt to summarize his report. Although in some instances we use the author's words, we more often paraphrase for the sake of condensation.

The mature female whose behavior von Allesch describes was a member of the chimpanzee colony in the Canary Island Anthropoid Station. After the abandonment of the Station she and her companions were brought to the Zoölogical Garden of Berlin where they arrived on October 17, 1920. Formerly known as Rana, she was renamed Loca in Berlin. From the reports of Köhler it is apparent that Rana was slow in adaptation and apparently dull and stupid. She was observed to menstruate late in October, 1920, whereupon the process ceased. April 1, 1921, parturition occurred under the circumstances previously described. Von Allesch in his report overlooks the previous birth of the chimpanzee Anumá in Havana, and, unaware of the report of Montané, incorrectly states that the birth described by him in Berlin is the first instance of the kind to be scientifically observed and recorded.

The foregoing descriptions of maternal behavior in the chimpanzee suggest the observations of Abreu.

Of the birth of Lita it is reported by Madam Abreu that her negro servant Andres was attracted early in the morning by Monona, who rattled the chain which held her. He loosed the animal and turned to attend to other duties. Returning shortly he discovered that a baby chimpanzee had been born but was seemingly dead. Presently the mother began to work over it, breathing into its mouth and drawing its tongue out with her lips. After a period of this treatment the infant began to breathe. She then cleaned it thoroughly and subsequently chewed at the umbilical cord until it was shortened to about a half yard. Somewhat later she chewed it off close to the body of the infant.

Was the adaptive behavior of Monona toward her new-born infant indicative of insight, intuition, or instinct? Its suitability is obvious. If the infant had been neglected, it probably would have succumbed. Behavior of this sort is impressive and not the less important or suggestive of biological problems if performed without insight. One can

> but wonder how many inexperienced human mothers would act as appropriately. The subject is of extraordinary interest, but it is freely granted that the behavior of Monona may not indicate a high level of intelligence. (Yerkes, 1925, pp. 75-76.)

Thus it would appear that from three quite different sources (Abreu, as reported by Montané and Yerkes, von Allesch and Fox) we have evidence that the mother may in various ways manipulate the infant and thus stimulate respiration and circulation. Possibly the former may in some instances be induced by such manipulation. The matter is of signal importance and we therefore give this particular and emphatic statement.

The first cry of the Berlin infant, a moderately high tone like the U of the adult chimpanzee, was first heard the morning of the second day. During the day it was often repeated, always as a single tone.

When born the head, shoulders, and back of the infant were covered with long black hair. The bare skin of the face, hands, and anal region is described as light rust color, tender, transparent, and not pronouncedly wrinkled. The finger nails were long and narrow (1921a, p. 675). No physical measurements are given by von Allesch.

After three months the height of the infant is said to have doubled, "yet an exact determination is difficult." Whereas during the early days of life the visible portions of the skin were rust color or orange-brown, after some two weeks they became lighter and sepia-colored; and still later, a light rather grayish flesh color. Toward the end of the fourth week the original hair, especially on the head, began to fall out. The mother assisted the process by pulling it out. After a few days the infant was nearly bald, but within a week new hair appeared, slightly less black than the original coat, and not so long. At the same time the voice was undergoing a change. The prolonged U was first heard after fourteen days, and for some time occurred only as an "answer." Spontaneous sounds appeared after the fifth week, and one might then sometimes note sounds of discontent, of playful scolding, or of fear when there was disturbance in the cage (pp. 683-684).

From the first the infant clung to the lower part of the mother's body, with hands and feet clutching her hair and protected by her thigh and often also by one of her hands. In this position, von Allesch informs us, the little one remained much of the time during the first days and weeks. This was its position in sleep and also when the mother moved from place to place. Where the hair and skin of the female were grasped by the infant folds arose, but there was no indication that this stretching of the skin caused discomfort. When the mother lay upon her back the infant seldom changed position, although it somewhat relaxed its grasp, and subsequently was observed at such times to make attempts to creep. Occasionally the infant was carried somewhat to the side, instead of in the middle of the belly, and at times in the groin (p. 674).

To this description we may add from our own observation that after achieving freedom and skill in locomotion the infant may still cling to the belly, sides, or back of the mother, or even ride astride the back, holding lightly or securely as circumstances demand.

Intimately related to the position and mode of carrying the infant is the following observation of von Allesch relative to rhythmic rocking by the mother. We quote in free translation his interesting description.

> From shortly after parturition the mother trembled much, probably because of general exhaustion. Although this trembling sometimes extended to the entire body it was more particularly noticeable in the arm and region of the thigh. During the second week it was noted that the trembling of the thigh resembled a see-saw movement, and somewhat later one could see that the body of the infant was set in rhythmic motion by the mother who with her arms rocked or patted it on the back. This activity gradually became more pronounced and appeared as a means of quieting the infant. Apparently, however, it was used more often when the mother was emotionally disturbed, as in anxiety or fear of danger, than when the

infant gave expressed discomfort or fear. (1921a, p. 684.)

On the morning of the 4th of April, the third day after birth, the infant was observed to move its head here and there as if seeking for something. It was too low on the body of the mother to find the breast. Shortly it twice cried out and moved convulsively. The mother then grasped the infant with her hands and shook him first against the floor, then backwards and forwards, bent him forwards, and then pushing him against the breast lifted him so that the left nipple went into his mouth, which immediately closed about it. . . . Sucking lasted for about five minutes and was soon repeated in like fashion, the breasts apparently being alternated regularly. This act of maternal shaking of the infant preparatory to nursing was several times observed. There were variations and at times the mother pushed the little one so far that its body actually struck the floor. Sucking rapidly became more vigorous and from the next day, April 5, on, the cheeks of the infant could be seen moving in and out. A few days later the process was clearly audible. Finding the breast continued however for "a long time" a difficult problem. The infant sought for the nipple with open mouth, at first by means of head movements alone, the remainder of the body continuing in its customary relation to the mother. "These movements of the head were not for several weeks made purposeful, but the head with open mouth was turned aimlessly on all sides. Even when the young one accidentally touched the nipple with its hand, it was no guide." The mouth might be within a centimeter of its objective, yet no evidence of definite directive influence appeared. Odor seemingly did not aid. (Von Allesch, 1921a, pp. 675-676.)

Continuing description similar to the above, von Allesch emphasizes the long continuing indefiniteness of the infant's search for source of nourishment. Occasionally success was quickly achieved, but more often after many fruitless attempts. Not infrequently exhaustion supervened and the quest was temporarily abandoned. And again it would happen that when after prolonged effort the infant had succeeded in locating the nipple, the mother for no obvious reason, and apparently quite careless of the desire and position of her offspring, would make some movement which indefinitely interrupted nursing. Noteworthy also is the following. With the infant seeking food or lying quietly on her body, the mother with sudden impulse would take him up, press his head to her body, and holding him fast look at him long and intently.

Mention was earlier made of the cleaning of the infant by the mother immediately after birth. Like attention to the bodily condition of offspring continued during subsequent weeks. The skin was examined frequently, although not systematically and completely, and in general the body of the infant kept clean and in entirely hygienic condition. This extended even to what appears to be effort on the part of the female to develop in the infant definite habits of evacuation of intestine and bladder.

Between birth and the end of the third month of life the activity of the infant became more marked. Very gradually it achieved independence. Again in free translation we quote:

Preparation to free the infant from dependence upon the mother thus manifested itself. It began when Rana, seated with legs outstretched upon the ground, laid the infant on the ground without removing her supporting hand. At the same period she was permitting him much greater freedom on her own body, for he was allowed to creep up to her ears and along the side under her arm, whence he could feel even along her back. It was the middle of June when such behavior appeared and the little one was well advanced in his third month of post-natal life. Next he was permitted as the mother sat on the ground to crawl over her legs, but not so far that he entirely lost touch with her. Seemingly he did not as yet dare to risk such measure of independence, for with one hand at least he always held fast energetically to his mother. At first he was not able to stand upright on his legs, but with each effort tumbled down. It was at this time that the mother discovered a wonderful play. Lying upon her back and holding one leg of the infant with one of her feet she would let him scramble over her body and then suddenly pull him back into position. (Von Allesch, 1921a, p. 685.)

Thus gradually the infant became accustomed to exert himself in various ways. Shortly the mother was observed to hold him above the ground, his legs dangling in the air and seeking for a hold. Thus appeared opportunity for practice in grasping and holding. But best of all, says von

Allesch, were the infant's attempts to walk. The mother, standing near, held the young one by one hand and compelled him to follow on three legs, or again placing him in front of her she would lead him. Thus von Allesch (p. 685) confirms the Abreu description (Yerkes, 1925, p. 191) of maternal tuition in walking.

The female, after giving birth to the infant, continued gentle and friendly with her human attendants as also with her chimpanzee companions. The latter, when admitted to a view of mother and baby, exhibited intense curiosity, but in no wise disturbed or interfered with the welfare of the pair. Throughout the period of infantile dependence this attitude of maternal gentleness, restraint, and conciliation persisted, and Rana, or, as von Allesch calls her, Loca, would go to very considerable lengths to avoid disturbance or even excitement which might endanger the welfare of her baby. That this involved nervous tension and persistent effort is suggested by the following change in behavior. No sooner had the infant achieved sufficient strength and independence to be reasonably safe from harm than the mother became irritable, suspicious, and often aggressive in her resentment of human or chimpanzee attentions.

Toward this her first-born, the mother exhibited persistent solicitude and interest. Her formerly stupid or foolish expression gave place to one of "earnestness and dignity" (p. 679). Physical changes also were notable. The profound exhaustion which lasted for about a week after parturition left the female weak and pale. Then slowly the pallor disappeared, and by the end of the second week her ruddy skin color had returned. The breasts, which at first seemed unchanged, during the first week somewhat increased in size. For several days the female habitually moved as with crutches, by placing her hands on the ground in the customary chimpanzee fashion and swinging her body, as well as that of the infant, forward. Usually one of her legs was used in locomotion while the other supported the infant, or again a hand and arm would be placed about the infant and the other three members used for locomotion. Difficult methods of progression were avoided and in all ways the mother sought to safeguard her offspring (p. 684).

Von Allesch, as we have attempted to indicate above, has contributed substantially to knowledge of parturition and infantile behavior in the chimpanzee. Yet obviously merely the beginnings of the story of life history have been written. Diligent search of the literature aids us little in supplementing the descriptions of von Allesch, Montané, Blair, and Fox. Nevertheless, for the sake of historical perspective and to present references which have confirmatory or supplemental value, we shall further and more systematically discuss the relations of parent and young.

Looking backward for nearly a century we are not a little surprised to discover in Martin, as indicated in quotation, several important and relevant facts which have since been well established.

> This Chimpanzee was brought over to England in September, 1835, having been procured on the Gambia coast, about 120 miles in the interior. It was a nursling in the arms of its mother, who was shot by its capturers. Her height is stated to have been four feet six inches. The young individual, at the time of its capture, was supposed, by the natives, to be about two years old; hence, therefore, it is improbable that the female should produce young oftener than once in two years; a mother may be surrounded by three or four young ones of different ages, forming a family, which continue long together in company. We learn that the Chimpanzees are usually seen in small troops, consisting of two or three families; and it is said that the females are devotedly fond of their young, which they nurse with tender assiduity; and that the adult males protect the females and their offspring with great resolution. It is, perhaps, when the females have retired to bring forth young, or when they are engaged with their newly-born progeny, that the males, guarding the precincts of their habitations (which are reported to be left, at this season, entirely to the females), have attacked persons unwarily venturing within their territorial limits. After all, it is with the disposition and manners of the young only that we can pretend to have a tolerable acquaintance. (Martin, 1841, pp. 378-379.)

The attachment of the mother to her young, since repeatedly noted, was long ago emphasized in the following words of Savage and Wyman:

> They exhibit a remarkable degree of intelligence in their habits, and, on the part of the mother, much affection for their young. The second female described, was upon a tree when first discovered, with her mate and two young ones. . . . Her first impulse was to descend with great rapidity and "make off" into the thicket with her mate and female offspring. The young male remaining behind, she soon returned alone to his rescue. She ascended and took him in her arms, at which moment she was shot. . . . In a recent case, the mother, when discovered, remained upon the tree with her offspring, watching intently the movements of the hunter. As he took aim, she motioned with her hand precisely in the manner of a human being, to have him desist and go away. (Savage and Wyman, 1843-44, pp. 385-386.)

We have presented relatively good evidence, considering the nature of behavioral literature on the anthropoid apes, that the chimpanzee mother is strongly attached to her infant, attends with care to hygienic demands, looks after the welfare of her offspring by safeguarding and protecting it, may direct and assist it in its early attempts to suck, and, after prolonged period of development in which it demands almost continuous support or holding to her body, encourages and assists the development of freedom of motion, and, finally, of locomotor ability by forms of instruction or tuition. Subsequently, mother and infant may in varying degree share in playful exercise as well as in search for food.

To characterize infancy and childhood briefly and at the same time adequately is virtually impossible. We have noted the principal observations which have been made on the traits of the infant, and we would now point out that the great majority of descriptions of chimpanzees which have been held captive in Europe and America refer to the periods of late infancy or childhood, since as a rule imported specimens are between two and five years old. Consequently there are many and useful psychobiological descriptions of the immature specimen of chimpanzee. To summarize in this volume these readily accessible, varied, and also frequently highly colored materials, we deem unnecessary. Instead we shall present a number of references for the guidance of the reader. Von Allesch (1921, 1921a), Bingham (1927, 1928), Brehm (1922), Broderip (1835), Buck (1927), Furness (1916), Hartmann (1885), Heck (1922), Huxley (1863), Kearton (1925), Köhler (1925), Kohts (1921, 1923, 1928), Martin (1841), Montané (1915), Nissle (1872, 1876), Passemard (1927), Reichenow (1920), Rennie (1838), Rothmann and Teuber (1915), Sheak (1917, 1923, 1924), Sokolowsky (1908), Traill (1821), Warwick (1832), Yerkes (1925), Yerkes and Learned (1925), Youatt (1835-36).

ADOLESCENCE

Except for the descriptions which have emanated from zoölogical gardens and experiment stations in which groups of chimpanzees have been observed, there are few reliable descriptions of adolescent traits. The best single source of information unquestionably is Köhler, who for a number of years daily studied the individual and social behavior of a group, the majority of whose members were adolescent. To his book on *The Mentality of Apes,* which might more suitably be entitled *The Mentality of Chimpanzees,* we would refer the reader for a multiplicity of observations and a body of knowledge which in this connection is quite invaluable.

By Bingham (1928) certain aspects of the social behavior of the animals in the Yale anthropoid colony have been observed. His descriptions, drawn chiefly from childhood, confirm many of the earlier observations of Köhler.

Similarly in the Abreu anthropoid colony a number of adolescent individuals were observed and their behavior briefly described by Yerkes, who, in addition to noting evidences of individuality and forms of social relation (1925, pp. 66 ff.), writes thus of aspects of childhood and adolescence.

The childhood of the ape is imperfectly known. Madam Abreu observed the development of Anumá, but, apart from playfulness and certain incidents indicative of individual peculiarities of temperament and intelligence, there is little to record. In this period it is definitely known that the individual emerges from the parental dependence of infancy to a degree of independence which enables it to shift for itself in captivity and to get on, in case of necessity, in the wild, either by adhering to another family group or by associating with brothers and sisters instead of with parents. With captive apes, the utilization of the first five years of life for training in seemly and healthful personal and social habits, is most important. This, although it may be time-consuming, assures convenience in the later management and care of the animal. To educate, re-educate, or reform a mature anthropoid ape is next to impossible, and even among the immature ones there are many individuals which are not worth the time of training. When the adolescent period begins, the responsibilities of the parent rapidly wane and the young ape associates more and more with individuals of its own age.

Quinta Palatino supplies in its chimpanzee colony abundant opportunity to observe the daily life of adolescent males and females. Anumá is at the end of adolescence and about to emerge into mature chimpanzeehood. Jackito, much younger and immature for his age, is in the very midst of adolescence. In the natural behavior of these caged young things, sex play frequently appears, perhaps more frequently than normally because of the limitations of caged existence, and, in the females, also the tendency to personal adornment. This we have repeatedly observed in females of adolescent age but never in males.

Beyond the age of adolescence the maintenance of an ape in health, comfort, and contentment is relatively easy apart from the difficulties of sex life with its disturbing demands. The adult is more hardy and seemingly more resistant to prevalent diseases than is the immature individual, and also less dependent upon varied activity and opportunities for social and especially for sympathetic relations. (Yerkes, 1925, pp. 231-233.)

Of physical changes in late childhood and of the transition from adolescence to maturity Heck says:

The change of teeth begins, according to calculations in captivity, not before the sixth year of life, although in individual cases the possibility always remains that the animal at the time of his capture was estimated too young. According to all appearances it is in the seventh or eighth year that the canines change. In one case there passed between the breaking through of the upper and lower canines a space of approximately two years, evidently an inhibiting result of captivity.

With the end of the change in dentition, according to all appearances, the female soon attains maturity, perhaps in the eighth year. She shows regular monthly menstruation, connected with a striking swelling of the external genital parts, which filled with blood take on the appearance of a light flesh-colored cleft pear. Timely swellings occurred in one case in preparation; after five days the swellings went down, although not completely; they remained permanent in a large measure at least in the chimpanzee females, "Johanna" of Barnums and "Missie" of Berlin, which are the only ones so far observed. (Heck, 1922, p. 660.)

During late childhood the chimpanzee achieves independence of parents and presumably also of other adult members of the social group. Simultaneously it tends to shift allegiance from the initial family connection to the band of immature individuals. There are no observations at present to indicate whether the latter type of group is usually constituted by children, adolescents, or both. Presumably shortly after the attainment of sexual maturity the individuals tend to rejoin the original group or to constitute new family groups. Whereas, then, infancy is characterized by dependence upon parents, childhood exhibits emancipation from this condition and acquirement of varied adaptations to the demands of physical and social environment. Throughout childhood, play is very conspicuous, and although this extends also into adolescence, the form of play activity changes in the direction of sex interest and becomes at once less varied and more definitely specialized.

GROWTH

At this point we may appropriately consider measures and other evidences of rate of growth and age. We have found only two measurements of weight at birth. Blair (1920, p. 106) reports three pounds. It was at first thought that the birth was premature, but this judgment was subsequently modified. For unknown reasons the individual never nursed, and at its death nine days after birth it weighed only thirty-five ounces. Fox (1929, p. 47) gives 1,720 grams

(3.8 pounds) as the weight of an infant about 48 hours after birth. Certain physical measurements for two fetuses of unknown age are presented by Friedenthal (1914). Unfortunately the weights of the von Allesch specimen and of the several chimpanzees born in the Abreu colony are not available.

Deriving his data from two captives whose ages prior to the measurements given below were estimated at three and nine years, respectively, Friedenthal (1914, p. 74) offers the series of measurements of weight extending from three to twelve years which we herewith present:

Individual 1		Individual 2	
3 years	29.76 lbs.	9 years	88.18 lbs.
4 years	36.38 lbs.	10 years	99.20 lbs.
5 years	41.00 lbs.	11 years	110.23 lbs.
6 years	45.20 lbs.	12 years	121.25 lbs.
7 years	51.80 lbs.		
8 years	55.55 lbs.		

Assuming that these measurements are accurate, there is grave uncertainty about the reliability of the estimate of ages. It may well be, for example, that either or both of the individuals in question was older. Of rate of growth in the chimpanzee as indicated by weight this observer remarks:

> With the anthropoid apes the increase in weight in the developmental years is very like that of man, so that the observed figures fall wholly within the breadth of variation of human growth. With the anthropoids the males especially increase very slowly in weight and size, while the females not only remain absolutely smaller but also cease to grow much earlier. Maturity begins in the anthropoids before the tenth year, a time when in man also precocious individuals attain maturity. The age changes appear in the anthropoids still earlier than in primitive peoples, and much earlier than in cultured peoples. (Friedenthal, 1914, p. 74.)

Many physical measurements on the chimpanzee are available, but it is practically impossible to evaluate them or to use them as norms of growth or basis for estimates of age, because as a rule neither the age nor the species or type of the individual in point is known.

Assuming that the chimpanzee achieves sexual maturity at from eight to twelve years of age, the attainment of maximum growth remains to be determined. We are unable to cite measurements. Whether it continues, as in man, for several years beyond sexual maturity we may not say, but the presumption is in favor of this inference. Maturity, as contrasted with childhood and adolescence, is characterized by increasing quiescence and seriousness of attitude. The excess energy which at earlier ages finds expression in play and seemingly random activity tends now to be directed into the more specialized avenues of reproduction. There is a marked lessening of fooling, indiscriminate expressions of curiosity, and a correlated narrowing of interests which seems to be accompanied by increased irritability and development of stolidity, or, frequently in captive specimens, of laziness and sloth. Of this Köhler remarks:

> The chimpanzees became more and more indolent when they attained sexual maturity; often they lay about in a sort of slumber nearly the whole day, and only roused themselves under the stimulus of mealtimes, or some intervention from outside. Perhaps their long captivity exercised an influence in this direction, as well as biological factors. But at the beginning of their time with us, their vivacity was unimpaired, and they occupied themselves in various forms of continuous play. (1925, p. 323.)

Age-changes, with reference especially to growth of the brain, eruption of the teeth, and bases of estimation of age, are discussed by Zuckerman (1928).

There may be found in Yerkes' (1925) description of the chimpanzees of the Abreu colony contrasting pictures of the behavior of juvenile, adolescent, and mature individuals. Especially in point are Chapters 3, 5, and 10 of *Almost Human.*

SENILITY

Senility in the chimpanzee is virtually unknown to science through direct observation. Those fragmentary references to it which appear in descriptions of the free life of the animal indicate lessening of activity and of suppleness, with markedly in-

creased quiescence and the approach of decrepitude. It is implied that the male when old often, if not regularly, loses his position as the dominant leader of the family group and may be ostracized. Frequently he is observed as an isolated individual. Whether this happens also to the aged female we do not know, nor do we know anything certainly about the psychobiological characteristics of the old male. It is said that he becomes ill-tempered, morose, and is likely to be dangerous.

SPAN OF LIFE

The chimpanzee's span of life is undetermined. Keith has thus summarized the facts and indicated knowledge, or rather the dearth of it.

> Regarding the natural term of life amongst anthropoids knowledge was only to be founded on indirect evidence, for it would not be possible to ascertain how long anthropoids lived in a state of nature. Captive anthropoids never died of old age. Of all the anthropoids the chimpanzee was the one which took most kindly to captivity; the record lifetime for a captive animal is 15 years; and of the hundreds which had been brought to Europe in recent times there were not more than six which survived ten years' confinement. Death took place in every case before all the teeth were cut. The evidence which had been collected points to the life-periods of the great anthropoids, the gorilla, chimpanzee, and orang as approximating the human rather than the monkey terms. (Keith, 1914, p. 224.)

On the assumption that for the chimpanzee the period of gestation is nine months and the age of sexual maturity eight to twelve years, it seems not unreasonable to suppose that the potential span of life may approximate that of uncivilized man. Although twenty-five years is probably not far from the greatest age of a captive specimen whose life history has been known for a sufficiently long period to justify estimate of age, there are excellent evidences in condition of teeth and of the skeletons of collected specimens, that this span may be very considerably exceeded. Probably fifty years may be considered a reasonably conservative potential age. The average actual age at death probably is very much lower, since presumably infant mortality is far from negligible, and the conditions of life are so unfavorable for senility, that unlike man the chimpanzee might be expected to lose in the struggle for existence long before death would result from wholly natural causes.

CHAPTER TWENTY-TWO

AFFECTIVE BEHAVIOR OF CHIMPANZEE: TEMPERAMENT AND EXPRESSIVITY

CHIMPANZEE temperament, disposition, and individuality, their nature and behavioral expressions, are the interesting topics of this chapter. Such information as we have about the affective life of the free wild animal—and it is meager indeed—consistently indicates a lively, sanguine disposition, tending in late life toward irritability or moroseness, which abundantly and in manifold ways gains expression through behavior. This general statement is entirely consistent with the marked sociability, gregariousness, locomotor agility, manual skill and versatility, and the quickness of response which characterize this great ape. Few writers have failed to note such affective characteristics; yet no one has offered a reasonably satisfactory picture of temperament and personality. Major difficulties in the task of description are the variations and complications due to age, sex, and individual differences. As great perhaps as the divergence in affective behavior between chimpanzee and orang-outan, or chimpanzee and gorilla, is that between chimpanzee childhood and maturity. No generalization from observation of immature specimens is universally applicable. And even apart from possible species differences in affective traits, the risks of one who would present a general picture are discouragingly increased by individual differences.

Almost all of the materials of this chapter are taken from the study of captive specimens. We would not venture to assert that they adequately or even generally portray the affective traits of the wild animal. In this matter ignorance dictates conservatism. It is our purpose, then, to try to picture accurately and vividly the affective characteristics of the chimpanzee, as known in captivity, by presenting either in their own words or in ours the principal observational data and conclusions of certain investigators, who under exceptionally favorable conditions and for years consecutively have studied one or another aspect of the emotional life of this ape.

As representative of zoölogical-garden authorities and observers we have selected Hornaday and Heck; of professional psychobiologists, Köhler, Kohts, and Yerkes. Two other and strikingly different contributors to our general picture we should mention here. They are Broderip, describer of the psychobiological characteristics of the London specimen Tommy, and the naturalist-photographer Kearton.

From Hornaday we quote the following passage to exhibit in the light of his extensive practical experience outstanding temperamental or dispositional characteristics of the captive chimpanzee in their relation to age.

> Except when quite young, the chimpanzee is either nervous or hysterical. After six years of age it is irritable and difficult to manage. After seven years of age (puberty) it is rough, domineering and dangerous. The male is given to shouting, yelling, shrieking and roaring, and when quite angry rages like a demon. I know of no wild animal that is more dangerous per pound than a male chimpanzee over eight years of age. When young they do wonders in trained performances, but when they reach maturity, grow big of arm and shoulder, and masterfully strong, they quickly become conscious of their strength. It is then that performing chimpanzees become unruly, fly into sudden fits of temper, their back hair bristles up, they stamp violently, and sometimes leap into a terrorized orchestra. Next in order, they are retired willy-nilly from the stage, and are offered for sale to zoological parks and gardens having facilities for confinement and control. (Hornaday, 1922, p. 15.)

As ever, exceptions test the rule. Horna-

day's generalizations are contradicted by many trustworthy records which we have before us, and as often by our own observations. Yet we do not hesitate to say that he is fully justified in writing as he does. For always it is a matter of essentials versus accidentals; of the normal or typical versus the variation. There are ugly-tempered young chimpanzees and good-natured old ones. But despite this seeming faultfinding with our zoölogical-garden authority, we are perfectly willing to accept his generalizations for our guidance when we meet strange chimpanzees!

The product of practical experience, not unlike that of Hornaday, and of intimate personal observation, is the following description by Heck of a gifted captive:

> He has witty caprices and allows himself jokes, not only upon animals but upon men. He shows preferences for objects which have no connection with his natural needs. For animals which, so to speak, have nothing to do with him, with whom he can neither cement a friendship nor come into any other relation, he is not merely curious, but is eager to know. An object which attracts his attention gains in value for him when he has learned to make use of it. He understands how to draw conclusions, to follow from one thing to another, to carry over certain experiences purposefully to relations new to him. He is sly, crafty, self-willed, but not stubborn. He demands what belongs to him without being dogmatic. He is aware of humors and moods; he is today cheerful and good-humored, tomorrow, sad and sulky. He enjoys himself in this company and is bored in that, enters into jokes which appeal to him and passes by those which do not. His feelings he expresses as man does; in good temper he does not really laugh but he smiles, at least he twists his face and takes on the unmistakable expression of amusement. Sad moods, on the other hand, he makes known not only through his features but also through lamenting sounds which everyone can understand, because they resemble human ones at least in the same degree that they do animal ones. Well-being he expresses by like means; ill-being as far as possible in the same way. In illness he acts like one in despair, throws himself on his back upon the ground, distorts his face, strikes around him with his hands and feet, rumples and tears his hair. (Heck, 1922, p. 665.)

We may not stop to comment on Heck's report beyond noting that almost everyone who has become intimate with a captive chimpanzee and has attempted to describe its temperamental characteristics, has in effect verified and supplemented our quoted authority. Indeed, the popular and semi-popular literature is filled with such descriptions.

We refrain from quoting those who, as handlers of trained animals or as trainers, know the chimpanzee both sympathetically and intimately, for we have not been able to discover that their observations in significant ways supplement those of the psychobiologist. We would, however, at this point refer especially to the publications of Brehm (1873), Sokolowsky (1908), Knauer (1915), and Sheak (1917).

Unexcelled are the opportunities which Köhler enjoyed for careful observation of a group of immature chimpanzees, and correspondingly important and extensive are his contributions to our knowledge of their life. Because invaluable data concerning affective behavior are distributed through his several publications it is peculiarly important that a *résumé* of his discoveries be prepared. Yet the variety and unrelatedness of observations render the task not only discouraging but in our present situation entirely inexpedient. We must content ourselves, therefore, by recommending to the reader careful study of his account of the psychology of the chimpanzee (1921b) and also of his *Mentality of Apes* (1925). Already we have quoted extensively from Köhler to supplement our descriptions of various aspects of the natural history of the chimpanzee, and we would now offer certain paragraphs which relate especially to individuality and temperament.

> To the seven animals mentioned, two others were added later, both of which led to valuable observations, but both of which, to our regret, soon died. I shall briefly describe them in order to give an impression of the completely different "personalities" which exist among chimpanzees.
>
> Nueva, a female ape, about the same age as the other little animals (four to seven years at the time of the majority of our experiments), differed from them bodily in her extraordinarily broad ugly face and an obviously pathological sparsity of hair on the unhealthy skin of her body. But her ugliness was completely offset by a nature so mild

and friendly, of such naïve confidence and quiet clarity as never fell to our lot to meet with in a chimpanzee before or after. Her childlike attachment we found, it is true, to some extent in other animals when they were ill, and perhaps a good many of Nueva's good qualities can be explained by the fact that, from the beginning, she was the prey of a slowly-advancing disease; chimpanzees, on the whole, can do with a little suppression. We were particularly impressed by the way she would play for hours, quite contentedly, with the simplest toys. The others, unfortunately, tend, in time, to become lazy, if they are not given any particular employment, or if they are not quarrelling, or attending to the inspection of each other's bodies. In this case, as little as in any other, is it conducive to judicious even though playful activity, if a number of healthy children are left together all the time, without any particular occupation. Nueva had been kept alone for many months. One must, however, not assume that the pleasant qualities of this animal were due to earlier educational influences. Unfortunately, it does not seem possible to make of a naturally mischievous and wanton chimpanzee an amiable being by education; but what is more important, Nueva was not "brought up" in the nursery sense; on the contrary, she showed that she was not used to being corrected at all. She regularly ate her excretions, and was first astonished and then extremely indignant, when we took measures against this habit. On the second day of her stay at the station, the keeper threatened her, during this proceeding, with a little stick, but she did not understand at all, and wanted to play with it. If food which was not justly hers, and which she had, with complete naïveté appropriated somewhere, were taken away from her, she would bite, in her sudden rage; she was as yet without any inhibitions towards man; in fact, she showed herself completely naïve, and was, without doubt, less "cultured" than the station animals.

The male, Koko, judged to be about three years of age, was a type of chimpanzee not uncommonly met with: above his drum-taut stomach a pretty face with a tidy parting, a pointed chin, and prominent eyes which seemed always discontentedly asking for something, giving the little fellow a native expression of sauciness. A large part of his existence was, in fact, spent in a kind of chronic indignation, either because there was not enough to eat, or because the children dared to come near him, or because some one, who had just been with him, dared to go away again, or finally, because he did not remember to-day what he had done in a similar test yesterday. He would not complain; he would merely be indignant. Usually this mood was manifested by loud pommelling with both fists on the floor, and an agitated hopping up and down in one spot; in cases of great rage by glottal cramp-attacks which passed over quickly. (These we noticed in other chimpanzees too when they had attacks of rage, but very rarely in manifestations of joy.) Before such attacks, and in cases of minor excitement, he would utter a continual staccato ŏ in that irregular, but characteristic, rhythm which one hears from a slow-firing line of soldiers. In his angrily uttered demands, and his wild indignation if they were not immediately satisfied, Koko resembled another egoist *par excellence,* Sultan. Luckily—and perhaps that is no accident—Koko was, at the same time, just as gifted as Sultan.

These are only two chimpanzees. For one who has seen Koko and Nueva alive, there is no doubt that in their own way they were as much unlike as two human children with fundamentally different characters, and one can set up as a general maxim that observations of one chimpanzee should never be considered typical for all of this species of animal. The experiments we describe in the following show that there are just as great individual differences in the intellectual field. (Köhler, 1925, pp. 5-7.)

The reader who is not familiar with the chimpanzee may well be surprised by Köhler's use of the word personality. Indeed, even individuality may cause him to start. But to such incipient skepticism or opposition we would offer the plea that the facts be considered open-mindedly and as nearly as may be in their completeness. Our observations convince us, as do Köhler's, that such terms as temperament, individuality, and personality are as useful, nay even as essential, in the description of the chimpanzee as of man.

Again we would invite Köhler to speak for himself on the emotional expressions of his subjects.

The chimpanzee's register of emotional expression is so much greater than that of average human beings, because his whole body is agitated and not merely his facial muscles. He jumps up and down both in joyful anticipation and in impatient annoyance and anger; and in extreme despair—which develops under very slight provocation—flings himself on his back and rolls wildly to and fro. He also swings and waves his arms about above his head in a fantastic manner, which may not be unknown among non-European races, as a sign of disappointment and dejection.—I have never seen anthropoids *weep,* nor laugh in quite the human sense of the term. There is a certain resemblance to our laughter in their rhythmic gasping and grunting when they are tickled, and probably this manifestation is, physiologically, re-

motely akin to *laughter*. And, during the leisurely contemplation of any objects which give particular pleasure (for example, little human children), the whole face, and especially the outer corners of the mouth, are formed into an expression that resembles our "smile."[1] I have already mentioned the habit of scratching the head when uncertain and in doubt, but to scratch the whole surface of the body, especially the arms, the breast, the upper portion of the thighs, and the lower abdomen, and against the direction in which the hair grows, is expressive of a wide diversity of emotions; we have nothing exactly corresponding thereto, at least among Europeans; after all, we no longer have fur or hairy covering long and dense enough to stand on end so effectively as a chimpanzee's.

Chimpanzees understand "between themselves," not only the expression of *subjective moods* and emotional states, but also of definite desires and urges, whether directed towards another of the same species, or towards other creatures or objects. I have described the manner in which some of them used the "language of the eyes" when in a state of sexual excitement. A considerable proportion of all desires is naturally shown by direct imitation of the actions which are desired. Thus, one chimpanzee who wishes to be accompanied by another, gives the latter a nudge, or pulls his hand, looking at him and making the movements of "walking" in the direction desired. One who wishes to receive bananas from another, imitates the movement of snatching or grasping, accompanied by intensely pleading glances and pouts. The summoning of another animal from a considerable distance is often accompanied by a beckoning very human in character. The chimpanzee has also a way of "beckoning with the foot," by thrusting it forwards a little sideways, and scratching with it on the ground. Human beings are often the recipients of invitations by a gesture of what the animals want done; thus, Rana, when she wished to be petted, stretched her hand out towards us, and at the same time clumsily stroked and patted herself, while gazing with eager pleading. Another obvious method of invitation is for an ape to assume or indicate in his own person whatever movements he would perform in the activity he wishes the other to undertake, in the same way that a dog invites us to play with him, by leaping and running, and then looking back towards us. Anthropoids behave in the same way in inciting others to play with them, to have sexual relations with them, or to join with them in that mutual inspection of the skin and hair which is one of their most absorbing occupations; in all cases their mimetic actions are characteristic enough to be distinctly understood by their comrades. When I grew tired of tickling Tschego's back and ribs, which always delighted her, she would still come and stand before me in that crouching position typical of a human being or anthropoid who is being tickled, and would make their habitual vaguely-defensive gestures as well. —But there is a sharp barrier to mutual comprehension, when one of these apes sees another executing new and intelligent, though unfamiliar actions. (Köhler, 1925, pp. 318-320.)

[1] "Though the chimpanzee at once correctly interprets the slightest change of human expression, whether menacing or friendly, he seems permanently incapable of understanding merry human laughter."

Undoubtedly Kohts, from her extensive experimental study of visual perception in a young male chimpanzee, acquired unusually intimate acquaintance with the affective characteristics of her subject. Already we have quoted (p. 212) her brief characterization of Ioni. At this point the passage may well be reread. Fortunately the illustrations of her principal report on visual perception in the chimpanzee constitute a uniquely valuable contribution to the study of affective behavior. From certain points of view they are far more desirable at this stage of psychobiological research on the anthropoid apes than are verbal descriptions. Whereas Köhler has given us words, Kohts offers photographs of her subject in important phases or stages of affective reaction. We are glad, by her courtesy, to be able to reproduce several pictures of emotional expression. They are fitting substitutes for verbal quotation, and they have the special advantage of supplementing the materials which we have previously offered.

Our search of the literature has revealed no photographic records of expressivity in the chimpanzee comparable in excellence with those of Kohts, but in a report of von Oertzen (1913, opposite p. 19) appears a plate which represents chimpanzee grief, joy, curiosity, and astonishment. There is no quotable or significant text description accompanying the illustrations.

Yerkes, whose observations although obviously incomplete and inadequate as basis for general description extend from the infancy to the maturity of the chimpanzee, presents a sharply drawn picture of the temperamental contrast exhibited by two specimens in early childhood.

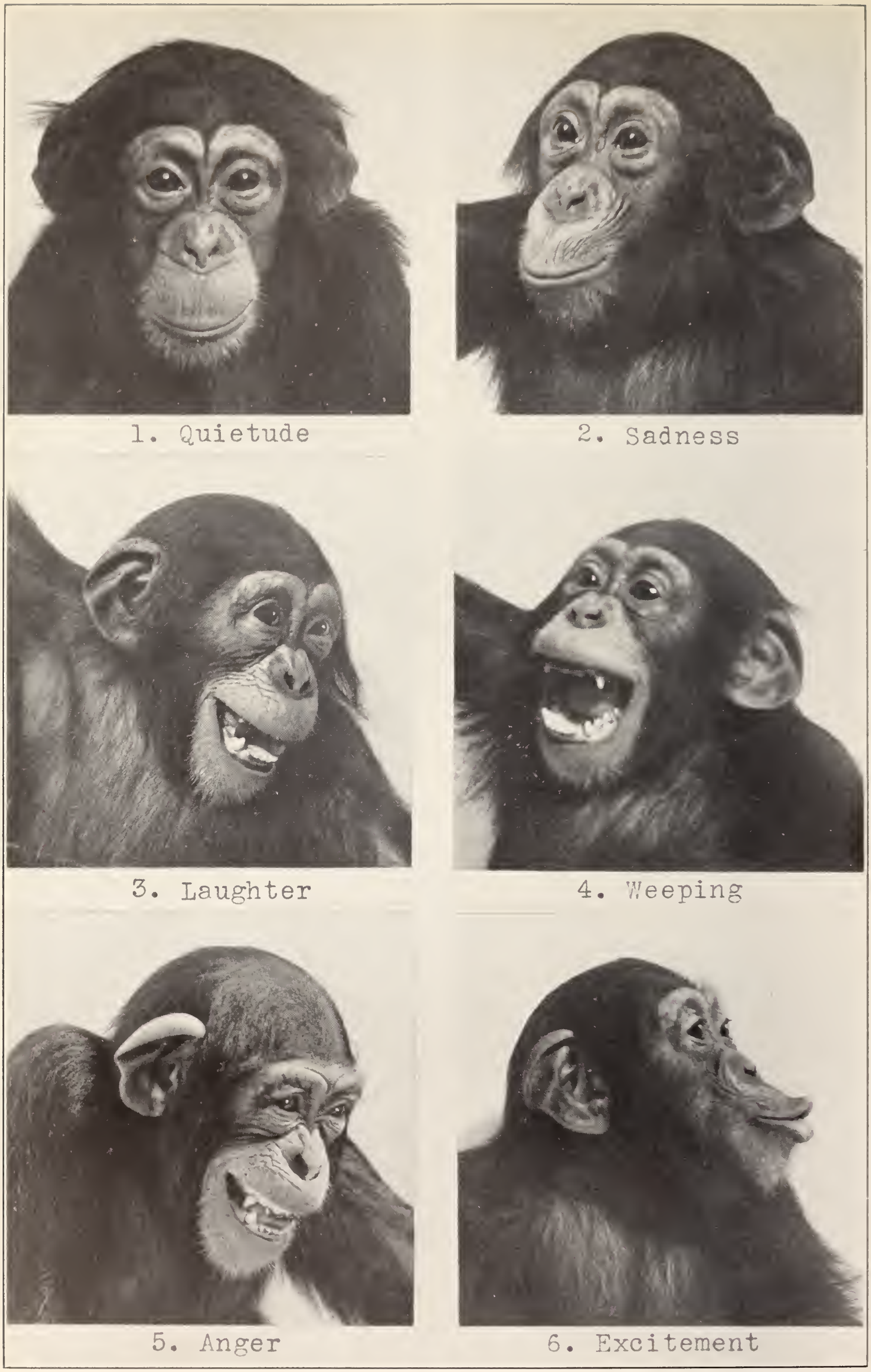


Fig. 98. Emotional expressions of the young chimpanzee. These excellent pictures of facial expression, made in the laboratory of Mrs. Kohts, in Moscow, are reproduced by her courtesy and that of the Century Company.

In brief, Chim is sanguine, venturesome, trustful, friendly, and energetic, whereas Panzee was distrustful, retiring, lethargic. His behavior usually suggested unusual intelligence; hers stupidity.

In their relations to people the animals exhibited their usual diversity. Chim would go willingly to almost anyone who seemed friendly. Panzee's reaction was difficult to predict. Sometimes she would meet advances more than half way. Occasionally she would seek out a stranger. Both animals appreciated kindness. Panzee's mode of expressing appreciation was a gentle pat on her attendant's shoulder. This she administered rarely, and only when she was deeply grateful for friendly consideration. Chim has never been observed to express his feelings in this manner.

Chim's preference for persons who were in a measure responsible for his care and conduct seems to depend chiefly on their disciplinary attitude. He approves them in the order of their indulgence. Those who allow him to have his own way and are pleasant and kindly about it hold first place in his esteem. Those who demand obedience and enforce reasonable regulations are respected, but not sought after! Chim when punished, or threatened with punishment, habitually strives to escape the disciplinarian. Panzee instead would crowd upon the person and strive to get into his arms. This remarkable difference in response to punishment deserves study. It may prove to be characteristic of sex.

Chim in a few instances exhibited his friendly spirit toward human companions by bringing objects to them. A case in point is the careful plucking of some blossoms one day in the New Hampshire pasture and the presentation of them to a lady attendant.

Both Chim and Panzee when in the great out-of-doors romped more or less boisterously, he especially so. They also on occasion threw themselves on the ground with utter abandon and, relaxing completely, rested in obvious comfort. Frequently Chim would stretch out on his back in the pasture and with his hands under his head bask in the sunshine. Panzee never assumed this attitude. It was strikingly suggestive of a human attitude of relaxation. Opportunity for play was eagerly sought, especially by Chim, and occasionally by Panzee when she was feeling well. Chim went to considerable lengths to invent modes of amusement when alone and games that he could play with human companions or with Panzee. He is extremely fond of being chased about, also of chasing things which try to escape him. When playing with a person he expresses his emotions in two peculiar ways. The appearance of these expressions depends on his relation to the person and on his mood at the moment. With me he frequently stops, and shaking his left hand vigorously, completely relaxing it at the wrist, stands erect, and with mouth open and teeth exposed assumes a fighting pose. That this is play I have repeatedly demonstrated by putting my hand or finger into his mouth. He has never bitten me, but he immensely enjoys the mock attack and defense. Sometimes he will jump up and down swinging his arms and waving his hands as if they were pivoted at the wrist.

The other amusingly expressive reaction in connection with play he has never exhibited in his relations with me, but several times when romping with a lady attendant or with a small group of admiring observers at hand. The act consists in either standing on his head or resting on his hands with head near the floor and throwing into the air either one or both legs, at the same time shaking it or them in a manner which suggests complete relaxation. This leg movement is similar to the hand movement described above. The whole performance makes the observer feel that he is trying to give one the chimpanzee "glad hand." The peculiar thing about it is that he should use his leg instead of his arm.

Fondness for music or at least for rhythm was exhibited by the animals, but more particularly, perhaps because of his more abundant energy and activity, by Chim. On occasion he would dance about keeping time to music and showing appreciation of rhythmic sounds and of the excitement attendant on music and human companionship. Panzee never danced and, although interested in music, gave no clear indication of satisfaction in it. It is not improbable that the dance movement in the young male is related to courtship behavior. (Yerkes and Learned, 1925, pp. 30-32.)

The above description of Chim and Panzee is supplemented by a passage in *Almost Human* (Yerkes, 1925, pp. 245-249).

Several times we have referred to psychobiological changes during development. These certainly are no less obvious in affective traits than in any which we may oppose to or contrast with them. Whereas the differences in emotional expression between infancy and maturity or childhood and senility are extreme, those between any one of them and adolescence are no less interesting. Individual differences, as well as affective characteristics of adolescence, are exhibited by the following observations from the Abreu primate colony.

Housed in the same cage are the adolescent female chimpanzees Malapulga and Sita. More strikingly contrasted temperaments it would be difficult to find even among persons. The one is antisocial, the other distinctly social. Malapulga represents

the type of creature which commands allegiance through fear or not at all, whereas Sita commands it rather through affection. Thus in these animals as in ourselves may be observed from day to day the ability to develop or promote social relations on the basis of entirely different types of emotional attitude and expression. Where Malapulga would strike or bite, Sita would more likely caress or fondle. So temperamental differences are not necessarily sex-coupled and except on the basis of long and patient observation it is wholly rash to attribute even marked individual differences to species, sex, or age. Among other things, the particular experiences, fortunate or unfortunate, of the individual may be largely responsible for its temperamental traits or for their special manifestations. Conditions of development, status of health, the inroads of a disease, may be largely responsible for the existence or development of a particular trait of temperament or for aspects of docility.

Characterized also by temperamental differences which are illuminating, are the cage companions Jackito and Lu Lu. If Jackito were somewhat smaller the visitor might mistake him for Lu Lu's son. Certainly, she takes a motherly attitude toward him and attempts to command his respectful and affectionate attention. Jackito has the most spritely and mischievous expression of any chimpanzee in his community. Also he lives up to his looks! A better subject for portraiture could scarcely be asked. He seems to delight in having his picture taken. He actually poses and even changes expression to suit the convenience of the photographer. It is entirely unnecessary to command him to keep quiet, for he seems flattered by the opportunity to face the camera. This was so unexpected and peculiar that it especially commanded our attention.

Lu Lu, by comparison, is stupid, sluggish, and lacking in resources for self-entertainment or the amusement of others. Hers is a somewhat colorless disposition. When teased by Jackito, who frequently refuses to let her approach him, she often loses her temper and after pursuing him vainly for a time cries from disappointment or chagrin. At such times it is not Jackito's habit to come to her gently and comfort her, but, with the thoughtlessness and lack of feeling of a mischievous boy, he is more likely to try to discover new ways of tormenting her.

Cage-mate of these two contrasted animals is Blanquita the melancholy. If Jackito's face is the brightest and most mischievous of the community, certainly Blanquita's is the saddest. One might infer from her habitual expression that she had lost her last friend. If she feels as badly as she looks, hers must be a miserable affective life. Any one who doubts the existence of extremely different characteristics in individual chimpanzees need spend only a few hours before the cage of these animals to be convinced that they are quite as highly individual and quite as different in their traits of temperament and character, in their liability to and expression of tough and tender emotions as are we. (Yerkes, 1925, pp. 156-158.)

Accounts of the affective, or indeed any aspect of the behavior of the mature or senile chimpanzee, are few and unsatisfactory. One can think of two principal reasons: opportunities for satisfactory observation are relatively fewer than in the case of immature specimens, and the facts make less strong appeal to the sympathy and interest of most observers. In the main, descriptions of temperament and disposition in maturity and senility tell us of moroseness, irritability, savageness, or dangerousness to man, and unsociability. The following quotation adds a few touches to the picture, and others might be added from Bingham's (1927) description of parental play of chimpanzees.

Jimmy, morose old chimpanzee as he is, has not been observed to treat Lita unkindly. Now and again, as previously stated, he has outbursts of temper, provoked perhaps by jealousy, during which he yells in a terrifying way, rushes about the cage, seizes anything within reach, and shakes it as if to tear everything to pieces. He may even rush toward Monona and the baby, as though bent on injuring or frightening them, but nothing comes of the row except that the keepers on hearing the outcry immediately hasten to the cage and isolate the big male so that he may not in his frenzy accidentally injure either baby or mate. That Monona and Lita are afraid of Jimmy during these periods of excitement there can be no doubt, for the baby promptly runs to her mother and takes refuge on her back to which she clings tenaciously with hands and feet firmly grasping the hairy coat. Monona, on her part, takes refuge either on a raised platform under the roof of the cage or in a remote corner, getting as far as possible from Jimmy and in a sheltered position. This is discreetly precautionary, for within the narrow limits of the cage the male might do serious injury to his young if the mother did not keep it out of the way.

Apropos of these periodical outbursts of Jimmy, his owner says that the adult male chimpanzee, however good his temper and disposition, cannot be trusted since he is subject to "crazy spells" during which he may act most unnaturally and roughly. She always objects to having any one except herself or her keepers go into the cage with Anumá or any other well-grown ape because, as she puts it, one never can tell when the animal

may be seized by such a spell and either bite or rend one. Undoubtedly hers is a wise precaution. (Yerkes, 1925, pp. 193-194.)

Space fails us to review such historically interesting and useful accounts of the traits of early captive specimens as have been given by Tyson (1699), Traill (1821), Broderip (1835), and several other observers. They have been endlessly copied in admirable works, such as those of Rennie and Martin, as well as by authors whose ignorance is manifest.

In the foregoing we have endeavored by carefully selected quotation from competent authorities, no one of whom would wish to be considered infallible or even fully informed, and by pertinent comment and supplementation from our own experience, to make the personality of the chimpanzee live in the mind of the reader. We hope that we have succeeded in sufficient degree to impel many to seek further information in the original sources. But we are still dissatisfied because from our experience we know that personality as an abstraction lacks vividness and reality. Whatever measure of understanding of the life of the chimpanzee we have acquired is due to intimate acquaintance with individuals. Indeed, we consider this no less true of the chimpanzee than of man. Therefore, we would now make an unusual recommendation; namely, that instead of contenting ourselves as students of the affective life of the chimpanzee with studies of specific problems as they appear in scientific reports from field or laboratory, we should read, and then reread, Kearton's story *My Friend Toto*.

Cherry Kearton is known to us as naturalist-photographer only through his publications. Whether he is more or less competent, honest, careful as observer and describer than most or any of the hundreds of authors who have contributed the materials of this volume we do not know. We cannot say that we do not care, but we do know, with a degree of certainty that our scientific colleagues will find it difficult to modify, that the story of Toto is *true to life*.

We know not whether the author has circumstantially described what he saw or was told; whether the tale is fact, fancy, or a skilful mingling of the two; whether the facts relate to a single individual or several. Nor are we particularly concerned, for Cherry Kearton knows the life of the chimpanzee in an incomparable way, and his story gives one an appreciative understanding of its personality which ordinarily may be obtained only through intimate sustained acquaintance with an individual.

We should like to quote *My Friend Toto* in toto, without omitting the photographic illustrations. Instead we present only the "Foreword," the part as it happens with which we have most fault to find, because the author indulges in certain generalizations which we are not able to confirm. In particular, we disagree with him in the surmise that Toto as genius is one chimpanzee in a million and that his mind when observed "was always full-grown." We too have met and studied gifted chimpanzees, even perhaps in our aforementioned specimen Chim, the equal of Toto. But we should say rather that such animals may prove to be, in mental caliber, one in a hundred, a thousand, or ten thousand than one in a million. As to mental growth or development, we are assured by the data which Kearton presents that Toto instead of being approximately a year old (p. 20), was more likely between three and five years; and our total body of knowledge justifies the dogmatic statement that far from being mentally full grown during his companionship with Kearton, he was in the midst of a period of extremely rapid and important mental development.

In this book I write the life-story of a friend. In the beginning I took Toto as a pet, as a man may take a dog, or a small boy a white mouse. I thought he would amuse me on lonely evenings in camp, and that I should laugh at his antics as one smiles at the monkey of an Italian organ-grinder.

But before the end of his first day with me, I found that Toto was not "just an ape." The intelligence of apes varies, even as does the intelligence of men; but, out of every thousand, nine

hundred and ninety-nine could be classified together as either just above or just below the average. The thousandth might have far greater powers of intellect, and if it were possible to sort out apes in this way until one had grouped together one thousand of these thousandth animals, there might be one among the million that would be a genius among apes.

Such a work of selection is obviously impossible, yet Chance so caused the happening of things (if Chance we are to call it) that this, the millionth ape, came into my hands and was brought to England.

As this narrative will show, Toto very quickly ceased to be my pet and became my friend. There was sympathy between us, and understanding. If I was sad, Toto knew it instantly and came to comfort me; if he was frightened, he ran like a child to my arms.

Yet I hesitate to say that Toto was altogether like a child. A child grows. Her intelligence to-day is greater than that of yesterday. The candles on the Christmas-tree at which she merely blinked last year are something wonderful now, and she calls them "pretty"; next year she will know why they are there and will be sending messages to Santa Claus.

But Toto's mind, while he was with me, was always full-grown. He was as intelligent on the day when he first came to me as when he reached England; but he was less experienced. He had not seen the wonders of the world, which called every bit of his intellect into play. He had from the first the power of reasoning, but hitherto he had had comparatively little about which to exercise his brain. But directly he came to new experiences the brain was there, ready to work to the promptings of his curiosity.

I did not teach Toto. He was a perfect imitator, and the things he learnt to do he learnt simply by watching and copying. Sometimes when he made mistakes, as for instance when he first went into my bath, I took pains to show him exactly what to do, going through the movements slowly so that he should be certain of them. But that is the only kind of lesson I ever gave him, and none of the many wonderful things he did was in the slightest degree of the nature of "a trick."

Toto did not learn to talk. He would imitate my words and produce sounds to which he attached definite meanings. But I do not claim for him the gift of speech. It must be a matter of speculation whether he could have acquired that if he had come to me directly he was born. Probably his utterances would then have been more intelligible. But it is impossible to say that they could have been called speech.

On the other hand, he undoubtedly understood a great deal of what was said to him. He understood many words and even sentences in English, French and Swaheli, the language of the natives. This of course was a matter of association of certain ideas with certain sounds; but that in its essence is all that speech is to the most intelligent of us.

Toto, as I have said, was a genius among apes, and he was a real companion to me. I would not have this book show his intelligence if it did not also show that comradeship. (Kearton, 1925, pp. 11-15.)

To sum up, fragmentary information now available definitely indicates that, in general, the changes in temperament and affective expressions which occur in the chimpanzee between birth and senility are in many important respects similar to those in man. The ape's infancy is characterized by a marked degree of helplessness and insistent fretful or cheerful demands for parental attention; during childhood, good-natured irresponsible playfulness, buoyancy, and restlessness are dominant; in adolescence, the attitude toward life rapidly becomes more serious, as indicated by increased assumption of responsibility and transformation of play into the activities necessary to self-maintenance; maturity is synonymous with seriousness, and the organism becomes businesslike, direct in its social and other expressions, short-tempered, and also suspicious by comparison with the infant, child, or adolescent; finally, in senility, all of these latter characteristics tend to become exaggerated, and physical decrepitude tends still further to modify the picture and to convert what early in life was a buoyantly and joyously active creature into the personification of unsociableness and moroseness.

Readily we grant that these contrasts are crudely and also uncertainly drawn. Observations are too few and unreliable to justify dogmatic assertion or indeed anything except tentative description. We know, however, the general contrast between chimpanzee youth and age; know also that the animal is extraordinarily emotional throughout the course of its life as contrasted with the orang-outan and gorilla; that in general its temperament is sanguine rather than melancholy, that it ordinarily is good-natured, sociable and coöperative, friendly toward all the world, instead of irritable, aloof, and

resentful, as seems more likely to be the case in orang-outan and gorilla; and, finally, that it is highly extraverted or objective in its interests, instead of introverted or self-centered.

Yet, before the reader has had opportunity to contradict us, we would add that in the course of its life history the chimpanzee may very well exhibit transition from good-natured, alert, active, and varied expression of the joy of living to the picture of ill-natured, sulky, and slothful or helpless self-preoccupation. Is not this, we are asked, the passage from extraversion to introversion? Even admitting that there is ground for affirmative argument, we should continue to defend the objectivity of the chimpanzee, for after all an organism may not safely be described in terms of the traits of senility, nor even of completely achieved maturity. Therefore, we have attempted in the foregoing pages to give a picture of the affective traits of chimpanzee youth and early maturity, and although our description is far from complete or adequate, and doubtless in many respects inaccurate, we hope that it may encourage observational supplementation and redrawing.

Suggested, if not obviously justified, by available information is the statement that the chimpanzee is psychologically the most expressive of the primates. Whether man ranks above or below it we do not know, but for the manlike apes the definitely indicated order of diminishing expressiveness is: chimpanzee, orang-outan, gorilla. Because then of the diversity, relative accessibility, and human resemblances of its affective life, the chimpanzee is uniquely valuable as material for the study of problems of affective behavior.

Now that we have, in very general terms, characterized temperament and individuality in the chimpanzee, it is fitting that we examine more particularly and minutely modes and patterns of affective expression and present not only descriptive and classificatory categories, but also typical observational data. We shall begin with modes of expression.

MODES OF AFFECTIVE EXPRESSION

Because little is definitely known concerning internal forms of affective response, we shall limit consideration to so-called overt or externally observable phenomena. Systematic examination thereof suggests, for the chimpanzee, classification in the following seven categories. We propose this arrangement as practically serviceable rather than logically complete and exhaustive. Much descriptive information is available concerning each category, but in no case may we consider present knowledge satisfactory or even adequate for the differentiation of such distinctive affective patterns as we shall attempt to describe in subsequent paragraphs.

To each of the seven categories we shall here devote only a few sentences.

(1) Bodily attitude, posture, and pose. This, whether the animal be stationary or in motion, may be eloquent of feeling, emotion, mood, or sentiment; and although seldom alone sufficient for the identification of an emotion, it is frequently an important constituent. Elements belonging in this category are frequently discoverable in behavioral complexes of resentment, disappointment, timidity, dismay, dissatisfaction.

(2) Position, pose, and movements, often termed gestures, of head, trunk, limbs, extremities. The elements of this category are more numerous, varied, and therefore more frequently observed than those of the first category. Particularly noteworthy are the so-called gestures made with the head, limbs, and extremities. Frequently they are mentioned in the literature, though seldom with sufficient precision and minuteness of description to provide the reader with a definite picture of the organism. Certainly adequate account of almost every chief type of emotional pattern in the chimpanzee will be found to include elements of this important category.

(3) Facial expression. Chiefly contributory to this are the configuration, tension, and moistness of the skin, the general appearance, and motor or other changes in

eyes, ears, nose, lips, mouth, forehead, and cheeks. The eyes, although differing greatly in appearance with type and individual, are said not to change markedly in emotional expression, and although secretion in and about them varies, tears are not shed. Similarly the ears contribute rather by constancy of appearance than by mobility to emotional effect, and although nose, forehead, and cheeks change in appearance with contractions of the facial muscles, the conspicuously changing features are lips and mouth. There are indeed more varieties of lip and more configuration thereof than of any other facial feature. Thus, for example, the lower lip may be dropped and permitted to hang as in utter amazement. Both lips may be drawn back and the teeth exposed with wide-open mouth as in anger or rage. Again, they may be together extended forward as in childish pout of disappointment. To complete the list would unduly extend this paragraph. We would conclude it with the generalization that, although facial expression is only a part of the emotional pattern of a chimpanzee, it ordinarily is a very important part. It is, however, quite as unfair to the facts, and therefore as misleading, to present the facial expression as though it were the complete emotional response as it would be to overlook it. As expressive organs the eyes are less important in the chimpanzee than in man, the lips very much more important.

(4) Sound production—vocalization. Frequently this category is conspicuous, for the chimpanzee, unlike the orang-outan and gorilla, is capable of varied sound production and apparently delights in exercising its ability. The affective relations and values of sounds are manifest and usually unmistakable. Here we shall mention only a few forms of vocalization, since in a later chapter the subject will be considered fully and in its relations to language. Readily noted are such vocal expressions as whimpering, crying, grunting, shouting, screaming, chattering, or "talking."

(5) Appearance, condition, and configuration of skin and hair. These, of course, contribute to the facial expression and may well be included, in part at least, with category (3). But even so, the factors of response which we herein designate are of sufficient importance to justify a separate category. Configuration, texture and moisture of skin and hair, their variations and resulting changes in the appearance of the animal, may not be ignored by the observer who would completely describe an affective pattern. Position of the hair, lying or standing, straight or rumpled, certainly is no less important as affective factor than is configuration of the skin. Likewise, the functioning of the sweat glands figures as overt emotional response as well as a modifier of the condition and appearance of hair and skin. Aside from sweating, which in our observation ordinarily is less noticeable in the chimpanzee than in the gorilla, the most conspicuous factor belonging in this category is erectness of hair, commonly observed in anger and fear. Changes in the appearance of the skin correlated with blood supply, and comparable with blushing and paling in man, although doubtless occurring in the chimpanzee, are relatively inconspicuous because of the darkness of the skin and its partial concealment by a coat of black hair.

(6) Excretory and genital expressions. The condition and functional activity of excretory and external genital organs are manifestly factors in many types of affective response. Thus, for example, urination may occur, or manner and frequency may vary, in accordance with the nature of an affectively significant situation. Whether the internal organs are so affected that their functional activity is increased, or whether it is merely a matter of discharge, is not apparent from the literature. Likewise the bowels are influenced, and under emotional stress not only may defecation occur but this may happen repeatedly and the composition of the intestinal content may quickly be modified so that the condition becomes diarrheic. It appears also that the external genitalia commonly indicate the spread of stimulation, and turgescence of either male or female organs may appear.

Doubtless these excretory and genital appearances are the external indications of marked alterations in the functional status of the several excretory systems and also of the entire urinogenital system. It is in connection with this category that we find most troublesome the artificial line of demarcation between internal aspects of affective response and external or overt manifestations. Evidently biologically adequate and logically satisfactory description of emotional expression must necessarily comprehend all factors. Undoubtedly, however, it is wise for the psychobiologist to specialize for the present on overt factors and aspects of response.

(7) Social relations. Emotion in the chimpanzee is commonly shared because of the highly social nature of the organism and its tendency toward gregariousness. Social contacts and varying modes of association therefore are more or less conspicuous features of affective expression.

Any or all of these categories of expression may be represented in a particular affective pattern or emotion, but in spite of the considerable number and variety of expressional modes, the definiteness of types of emotional pattern is such that several so-called "emotions" may be recognized in the chimpanzee by facial expression, bodily attitude, or their combination. The number of such types of pattern is undetermined, and even the relations and variations of what appear to be distinctly different expressions are little known. Portraits of the chimpanzee in emotion, as presented by Kohts, von Oertzen, Yerkes, Kearton, and others, support our statement, although obviously they incompletely represent the affective life. A nearer approach to adequacy of representation may be obtained by the simultaneous use of motion picture film and phonographic record. Thus it is possible to represent action and to give the observer the "feel" of an affective episode.

CHAPTER TWENTY-THREE

AFFECTIVE BEHAVIOR OF CHIMPANZEE: BEHAVIORAL PATTERNS OF EMOTION

FROM the literature we would now present evidence of such assemblages of affective pattern as in us are designated by the following groups of terms: (a) timidity, fear, terror, shame; (b) suspicion, resentment, antagonism, anger, rage, hatred; (c) elation, joy, pleasure, happiness; (d) confidence, sympathy, familiarity, friendliness, affection, love; (e) depression, grief, sorrow, melancholy.

This is not intended as an inventory of "emotions," nor even of affective patterns of response, in the chimpanzee; we have no right at present even to attempt such an inventory. It is instead a list of those emotions which frequently are mentioned by observers and whose expressions are at least partially described.

TIMIDITY, FEAR, TERROR

THIS category, with gradually increasing complication of expression, and also intensification, shades from slight uneasiness through shyness, timidity, apprehension, and fear to terror. Modes of expression vary extremely with age, and importantly, although less markedly, with sex, individuality, and species. It has been definitely established that timidity and fear are highly unfavorable to experimentation with the chimpanzee, and the wise observer establishes a relation of mutual confidence and friendliness before attempting to proceed with inquiries.

Strange large objects, and especially animals, sudden loud sounds, and indeed unusual or in the human sense mysterious phenomena, are almost certain to startle and very likely to frighten or terrify the ape. That the response is wholly or in part innate or instinctive has not been definitely established by trustworthy observation. There is a widely prevalent and persistent superstition that the chimpanzee instinctively fears such members of the cat tribe as the leopard, panther, lion, and also all serpents. Of the fact that the picture of fear is induced commonly by such objects there can be no doubt, but this is far from establishing the innateness of reaction. Instead, it may be due wholly or chiefly to social tradition, parental tuition, and other forms of individual experience. We decline to commit ourselves to assertion because the essential information is not available.

The literature amply establishes the fact that certain members of the cat tribe are natural and dreaded enemies of the chimpanzee. Doubtless by reason of their agility, ability to climb, and quickness of reaction, the large carnivora frequently capture and destroy young apes, and possibly even on occasion adolescents or females burdened with young. Many authors have noted fear reactions to leopards or panthers on the part of captive chimpanzees. Thus, for example, Bowdich (1819, p. 440) refers to the "agony" of a young chimpanzee on seeing a panther near it aboard ship. Great fear of a stuffed leopard skin is reported by Pechuël-Loesche (1882, p. 240). Sheak (1924, pp. 126-127) says: "The leopard is the most dreaded enemy of this ape. Not long after Sally came into captivity, I had her sitting in a chair one morning when a leopard commenced his characteristic 'wood-sawing.' The chimpanzee jumped to the floor, ran to the cage, lifted up the door, hurried in, and closed the door behind her. She recognized the fact that the cage was as good a contrivance to keep enemies out as to keep her in."

Thus graphically Kearton (1925, pp. 38-41) describes the response of Toto to a lion in the wilds of Africa.

> A few yards away was a river, and a little dip

in the ground near its bank was filled with water, either from a hidden channel joining it to the river or else from a spring. Round this pool were the tracks where many animals had come to drink, and it was there that I expected to get my photographs. A few thick bushes, making a little clump about ten yards across, stood close to the pool, and I planned to hide amongst them with my camera. I walked towards the spot, happily enough, thinking of the good pictures that I could obtain without great difficulty.

Suddenly something touched my arm. It was Toto. He stood beside me, gazing first at the clump of bushes and then at me. At first he merely stared, as if uncertain whether an alarm should be given or not; then he seemed to make up his mind, and he pulled harder at my sleeve as if to draw me away, giving several of his deep-throated, warning grunts.

I stopped. I knew by that time that Toto did not give the alarm unnecessarily. Undoubtedly there was something hidden among those bushes. Whether it was any animal dangerous to man I did not know, but it happened that I was entirely unarmed, and I decided to make certain what lay ahead of me before going any closer. So I turned away, getting to a greater distance from the bushes, while I worked round to the other side, where I hoped to find a gap into which I could look. Toto kept close at my side, stopping after every few yards and standing upright to look behind him.

At last we reached the opposite side of the clump, and turning, I began to approach it again, rather more warily than I had done before. Suddenly I saw the leaves of the nearest bush move, and I stopped. Something was moving into the open from behind that bush . . . something yellow . . . a lion!

Several times I have photographed lions in Africa, but I would not go towards one without a weapon, although I should only use it in the direst emergency. But now I had nothing more effective than my camera tripod, and I quickly decided to retreat. In fact, I must confess that my main desire at that moment was to put five hundred yards between that lion and myself as quickly as possible.

But to have run would have been to invite pursuit. A man-eating lion will always attack if he thinks he has an easy victim. If I had turned to run, that lion would have been across my body, tearing at my flesh, before I had gone twenty yards.

I knew that my only chance was to face him squarely and edge quietly backward as best I could. At first I stood perfectly still, staring. It was a painful ordeal. I have no idea for how long I stood there, perhaps for a minute, or a minute and a half; but to me it seemed almost a matter of hours.

Slowly the lion moved, taking a few steps backwards. Then he turned and snarled, showing his fangs as if deciding that I was unworthy of royal attention. Slowly, I began to retreat. Toto all the time had stood firmly beside me, watching as I watched and waiting till I gave the word to move. Gradually we retreated together until we were nearly a hundred yards from that clump of bushes. Then at last I turned and hurried away, glancing back every now and again to make certain that there was no pursuit.

That night when I found Toto in my bed I did not turn him out.

Although the prevalence of expressions of fear is undeniable, we have not been able to discover in the literature on the chimpanzee proof of the innateness of the response. Many persons have observed it in field or laboratory but none under conditions which preclude the influence of social tradition or individual experience. At some length Broderip (1835, pp. 162-163) tells of the fear induced in the captive Tommy by a python which was placed near him in a hamper. "As he jumped and danced along the dresser towards the basket, he was all gaiety and life. Suddenly he seemed to be taken aback, stopped—then cautiously advanced towards the basket, peered or rather craned over it—and instantly with a gesture of horror and aversion and the cry of Hoo! hoo! recoiled from the detested object, jumped back as far as he could, and then sprang to his keeper for protection." The author further reports aversion to a tortoise, but nothing approaching the fear induced by the python.

Similarly, terror in the presence of a snake and strenuous effort to escape from the presence of it are recorded by Youatt (1835-36, p. 204). It is said by Nissle (1872, p. 207) that the captive chimpanzee Molly gave no indication of fear of snakes, but this author adds that the phenomenon is exceptional, since apes usually are terrified by serpents. Evidences of fear are supplied by Pechuël-Loesche (1882, p. 240), by P. Chalmers Mitchell (1912, p. 201), and by Kearton, whose description is at once so illuminating and quotable that we would again permit this author to speak for himself.

In particular he [Toto] was always terrified of snakes; and rightly so, for snakes must have ended the days of many of his young cousins at home.

It is no unusual thing in Central Africa to find on the ground the dried outer skin of a snake: for snakes shed a thin skin at regular seasons and glide away in all the glory of a freshly-grown covering, while the discarded coat lies where it fell on the ground. But Toto did not know that, and to him a snake skin must contain a snake. I remember that once we came upon the thrown-off skin of a big puff-adder. Toto very nearly trod on it. Then he bounded into the air, his hair quite literally standing on end. As time went on, Toto learned many things, but this, the snake which was no snake, was a mystery of Nature which was always beyond his understanding.

On another day, as we were going back to camp in the evening, Toto had wandered some ten yards in front of me, when suddenly a small snake slid out from behind a stone, passed right in front of Toto, and dropped into a crack between two rocks. Toto yelled with terror, then ran back to me, and stood, with his teeth chattering, holding his hand as if to show where he had been bitten. I examined it carefully, but could not see the tiny mark that would have been made by the snake's fangs. I made sure of this, and then told Toto that he was only frightened and that the snake had not touched him. He did not believe me. He had been so scared by the sudden sight of the snake that he was certain that he was hurt and probably imagined he was going to die. Knowing that this was not so, I tried to coax him to come back with me to camp. He would not come. I walked ahead, expecting him to follow. After a few paces, I looked back and saw the little fellow stretched out on the ground, convinced that he was too ill to move, and looking at me with piteous entreaty not to leave him. So I picked him up and carried him to my tent, where at last the sight of a bunch of bananas distracted his thoughts until he forgot his terror; and half an hour later he was sitting on my bed, playing as contentedly as ever.

But it must not be thought that Toto was a coward. He was very far from that. Of snakes he was always afraid. I never saw a chimpanzee that was not. And I don't think he had any particular friendship for crocodiles. Nor have I. But there was little else that he feared. (Kearton, 1925, pp. 35-37.)

We have already remarked that fear of strange large animals is commonly observed in the chimpanzee. The literature affords numerous examples of fear-responses to various sorts of cattle. Most frequently recorded are reactions to cows, oxen, or to large ruminants which are commonly found in zoölogical parks or circuses. A pertinent description of fear of a cow by a young chimpanzee is given by Garner (1896, pp. 124-125). And Köhler, in the following brief account of fear-inducing objects and events, mentions not only distrust of the cat, but terror induced by oxen and camels.

The behaviour of chimpanzees towards other animals varies according to the particular appearance or manner of the creature in question. Dogs, who rushed up at them outside the bars, leaping and barking excitedly, were promptly teased by kicks and jumps at the bars, by stone-throwing and stick-thrusting: the anthropoids gave no sign whatever of fear towards them. They were somewhat more reserved and cautious in their reception of a cat, who one day suddenly made her appearance in their playground. One or two slowly approached within a few steps and made half-playful, half-menacing gestures, standing upright and rocking to and fro from one foot to the other. And when the cat, "having had enough of it," arched her back and spat at them, the most daring apes retreated very quickly.

Even a practically defenceless creature can generally protect itself against these anthropoids, by inspiring sudden terror. When they were behind their bars every hen who ventured near them was treated as a toy, and often brutally enough, as were also such fowls as ventured into the playground. But one day Sultan wandered into a hen run, in which a proud mother was taking her tiny chickens for a walk. He approached them, but she flew at him with all her feathers ruffled, in the well-known hen attitude of defensive wrath, and in a second he had leapt the partition and was gone.

In general we may say that not only what has been experienced, or may be recognized as really dangerous, inspires fear in these animals, but also anything which has the phenomenological character of aggressiveness and "awfulness"—especially when there is the added factor of the strange and unknown. The same axiom holds good among themselves. When a small weak chimpanzee has become blind and reckless through intensity of anger, he can drive a much larger and more powerful comrade in headlong flight before him.

Large and uncommon animals caused a perfect panic if they merely came into the neighbourhood of the apes. On one occasion—it was quite by chance—two of the enormous oxen of Tenerife passed, drawing the primitive plough of the island up and down beyond the bars. The whole group of chimpanzees tore like creatures possessed, first one way, then another, each time as far as possible in the opposite direction from the monster; and tremblingly they hid their faces grown livid with fear. And indeed no purgative could have acted more drastically than did the spectacle of these rumi-

nants! Some camels only needed to pass by once, to make any experiments with the chimpanzees quite impossible for some time: an anxious and absorbed attention was turned exclusively in the direction from which the camels' bells were heard tinkling after they themselves had passed out of sight. (Köhler, 1925, pp. 331-333.)

Our observations support and supplement those of Kearton and Köhler, for we have observed pronounced fear-responses to cows, horses, and disguised human beings. Indeed, it is especially worthy of note that objects and events, which by man would be described as mysterious, tend to intimidate or even terrorize the chimpanzee. In the following paragraphs are indicated conspicuous features of the fear-pattern, contrasts as between maturity and adolescence, and finally evidences of the intimate relation between fear and anger and the ease of transition from one to the other.

The emotion of fear, with its incipient stage of timidity and its extremity of terror, gains expression in defense reactions. Vocal response usually is lacking. Instead of whining or screaming as in anger, the animal keeps perfectly quiet, as though to avoid attention. The pulse and respiration increase more or less markedly and as timidity develops into terror the hair becomes erect and the animal either holds itself tense and ready for flight, or, if the opportunity offers, silently steals away.

My best opportunity to observe fear reactions appeared in connection with brush fires and cows in the New Hampshire pasture. Chim was fearful of the open fire. Panzee paid little attention to it. Presumably experience is responsible for his behavior. His timidity in the face of fire either in the fireplace or in the pasture expressed itself by silent attention, alertness, and preparedness for retreat or flight.

When the animals were together approached by a herd of cows in the pasture they exhibited the fear reaction noted above, but in addition Chim sought Panzee's side and kept his hand on her shoulder as though to protect and direct her. When the cows were near and a person either stood between them and the chimpanzees or was beside the latter, Chim frequently would beat the ground with hands, feet, or both, as though to frighten the strange creatures away. This he did only when his natural courageousness got the better of his timidity. I have never seen him do it when his hair was erect and body tense in preparation for flight. Panzee never exhibited any of the defense reactions. If terror stricken she either scurried away from the object of fear or sought human protector. Both animals had complete confidence in their human companions and relied implicitly on them for protection against harm. (Yerkes and Learned, 1925, pp. 33-34.)

In the Abreu colony we observed that the mature male Jimmy and his adolescent son Anumá were readily intimidated by pistol shots. Both sought to escape from the terrifying sound and the presence of the man who manipulated the weapon. We have attempted thus to contrast their behavior and to exhibit certain implications.

Briefly, Jimmy in expression of fear and terror seemed the wild animal; Anumá, the intimidated domesticated animal. Jimmy is afraid even of a camera pointed toward him; Anumá shows no alarm. One can but wonder whether in Jimmy's case this is the result of experience in the wilds of Africa, or whether perchance during his life as a stage performer he was intimidated by the use of the pistol. Whereas Jimmy is easily stirred to anger, if not also to rage, and expresses himself in ways which are startling to the uninitiated visitor, Anumá is less readily aroused and decidedly less extreme in his expressions of emotion.

Fear and anger are closely related, and a situation which induces timidity, fear, or even terror will call forth anger, resentment, or rage if the animal sees that it has the advantage or mastery. The young chimpanzee faced by an unfamiliar animal or other object whose friendliness it cannot count on, is likely first of all to show timidity by trying to retreat without attracting attention. This failing, it may stand its ground, unwillingly but with bristling hair and tense muscles, waiting nervously for developments. If the fear-evoking object continues to approach, the ape presently becomes terror-stricken, makes a wild outcry, and either attacks or dashes for liberty.

If, on the contrary, the aggressor shows signs of timidity and willingness to retreat, the animal is quick to take advantage of this change by acting as though angry. The hair assumes its normal position and the animal may beat the ground with hands, feet, or both. It may even rush forward aggressively. Thus we see fear almost instantly replaced by anger, the difference in the situations being that in the first instance the animal feels that it is in danger, whereas in the second it detects the chance for mastery. Even very small chimpanzees—and the same is true of many other animals—strive to frighten away enemies or intruders by assuming a formidable attitude which ordinarily would be indicative of anger.

Already behavior has been described which clearly indicates dissatisfaction. The baby chimpanzee dashes to the ground the proffered cup of milk because the milk has not been sweetened, or it

refuses food because given something for which it has no particular liking. Anger and rage are commonly expressed in young primates by self-injury or even self-mutilation: dashing the body about, striking the head against objects, screaming and crying, not in a helpless, pathetic way, but aggressively and with every other manifestation of extreme resentment or rage. In some cases the lips may be drawn back, the jaws opened widely, and the animal may even attempt to bite the hand that feeds it. These are tricks of the young which evidently serve the useful purpose of getting what is desired. (Yerkes, 1925, pp. 152-154.)

RESENTMENT, ANGER, RAGE

THIS also is a category which finds frequent and varied manifestation in the life of the chimpanzee. There are all grades and shades of extent and intensity of expression, from mild dislike, jealousy, or resentment to bitter antagonism, hatred, anger, and rage. Although the literature is deplorably meager and poor in quality we are able to derive from it fairly convincing evidence, although entirely inadequate descriptions, of several modes of expression and affective patterns of this particular category.

Strange though it may seem, it is a well-authenticated fact that the chimpanzee resents being laughed at and is occasionally observed to retaliate or take revenge against men or other animals who laugh at it. Available reports do not indicate whether the laughter is resented as such, irrespective of its relation to the ape, or whether it is responded to as aspect of the social situation. Our own experience would suggest the latter, but we are unable definitely to establish the fact. By Nissle (1872, p. 205) an instance is recorded of a chimpanzee which was fooled by being given an empty paper bag when it expected one containing food. Being laughed at in its disappointment and discomfiture, it availed itself of the first opportunity for revenge by striking the person who had tricked it. Sheak (1924, p. 125) states, "It made Sally very angry to laugh at her when she was in trouble." Referring to certain efforts of Toto to imitate him, Kearton (1925, p. 48) remarks, "I laughed at that, and Toto, who always hated to be laughed at, flew into a temper." Already (p. 279) we have quoted Köhler on the subject. Our impression from several observations of this form of chim-

Fig. 99. "Napoleon," a young male chimpanzee in Philadelphia, expresses anger. Photograph by Newton Hartman, courtesy Alfred J. Collins and Philadelphia Zoölogical Garden.

panzee response is that it commonly appears when the animal is perplexed or otherwise in difficulty and is disturbed by what may seem like unsympathetic human behavior. Certainly the impression deserves intensive experimental study.

Appearances of jealousy are frequently observed, and either by avoidance or aggression an individual may display its resentment of preference shown to a companion. The reaction may be directed toward a human being who is giving attention to another chimpanzee, or instead toward the latter. We have many times observed such behavior in our subjects, and it is recorded by Sheak (1924, p. 127) and Köhler (1925, p. 307), among others.

Instances of marked and persistent antagonism as contrasted with transient dis-

like, resentment, or jealousy have been described. An instance cited by Garner (1896, p. 111) we have already described in his own words (p. 250). It is that of bitter antagonism between a young chimpanzee and his negro caretaker. Although our own experience supplies several cases of mild and transient antagonism, we have observed one only which is both bitter and enduring. The observations are unpublished; we report them briefly.

The case is one of suddenly appearing antagonism of a young male chimpanzee toward a man. The animal is of good disposition and naturally friendly to people. As far as discovered, the history of this affective attitude is that during an early meeting, and while playing with the chimpanzee, the man found it necessary to repel him repeatedly because of his insistent attack on clothing, and especially on buttons. Although this treatment was obviously resented at the time, no indication of anger or strong antagonism appeared immediately. Since the meeting referred to, between two and three years have passed, and during that time chimpanzee and man have met only a few times. In every instance the animal has exhibited strong antagonism. Among the conspicuous features of his aggressively expressed anger there frequently appear screaming or shouting, rushing toward the object of his antagonism, attempts to strike him with hand or to seize him with hands, feet, or teeth. In one instance when the reaction was especially intense, vocalization was accompanied by drawing back of the lips, wide opening of the mouth, transient erection of hair on back, and repeated urination and defecation. Evidently the animal was deeply stirred. The response is entirely exceptional in our knowledge of the individual, and is given despite consistently friendly attitude of the man and persistent effort on his part to win the good will of the chimpanzee.

What may appropriately be described as a temper tantrum frequently appears in the young chimpanzee. It seemingly corresponds to the fit of rage of the adult. Although the various factors or modes of response appearing in this expression of anger vary from individual to individual and from time to time, the principal ones may readily be indicated by reference to the seven categories which we previously enumerated and briefly characterized (pp. 285-287).

Under (1) bodily attitude or pose appears a tense bodily condition, often with extreme contraction of certain groups of muscles. Very commonly at some point in the expression the animal throws itself upon the ground and writhes violently, sometimes striking itself against surrounding objects, careless of minor discomfort or injury. Category 2, limb movements and gestures, is often conspicuously represented by vigorous pounding of the ground or surrounding objects with hands, feet, or both. Occasionally the head or some other part of the body is struck repeatedly with the hand, and still more commonly the hands and arms are waved in the air or held in unusual positions. Also there may appear varied gestures, as well as changing poses. Facial expression, although highly variable, commonly exhibits contraction of the lips, baring of the teeth, opening of the mouth in varying degrees, together with contraction of the skin of the forehead, slight movement of the ears, and alterations in expression of eyes and nose resulting from the changing facial contour. Vocalization almost always occurs. There may be a succession of shouts or a prolonged scream like that of the angry child. Frequently the vocalization is interfered with by a glottal cramp, and choking movements ensue. Skin and hair contribute to the general picture by reason of change in skin color, contour, and the position of the hair, and also because of increased secretion of the sweat glands. We have seldom observed erection of the hair on back or head, but this may appear. Excretory and genital expressions are common, but they tend to appear only in extreme intensities of anger; then urination and defecation appear, and sudden onset of diarrhea is not unusual. The external genitalia may become turgent and also increasingly conspicuous. Social

relations we find it difficult to characterize in this connection because seldom observed. The individual may either seek or avoid contact with its fellows or with the object to which it is responding. In our experience, avoidance is more frequent than contact.

Fig. 100. Mrs. Kohts's subject "Ioni" objects to experiments. Courtesy of N. Kohts and the Century Company.

In brief, the temper tantrum of the chimpanzee is essentially similar to that of the human infant or child when the latter reacts without effort at control. The phenomenon is frequently described in the literature, as for example by Rennie (1838, p. 69), Du Chaillu (1861, p. 286), von Oertzen (1913, p. 19), and Yerkes (1925, p. 154) who, as previously quoted on page 292, mentions among other interesting features of anger and rage in young primates the tendency to self-injury.

Anger and rage in the adult chimpanzee are startling indeed to the human observer. There are few descriptions, and none does justice to the facts even as now incompletely known. Keith (1899, pp. 298-299), referring to the captive adult Johanna, remarks: "When in a fit of passion, into which she is easily thrown, the hair of the scalp becomes erect, she beats the floor with her feet and hands, and utters a cry beginning with a low *hoo, hoo,* gradually raising it in volume to a loud climax." Often anger is induced by the behavior of a companion. Sheak (1923, p. 52) and Köhler (1925, pp. 65, 300) cite instances. The provoking agent may be an innocent victim of attack or it may be the aggressor. Peculiarly interesting and psychologically important are expressions of anger against inanimate objects, such, for example, as bits of experimental apparatus, and such barriers or obstructions as cage walls, doors, and locks. These frequently are attacked as though they were living creatures on which the angry chimpanzee seeks to vent its emotion. Köhler describes attacks of one of his subjects on a box which was used in a certain type of experiment (1925, pp. 44-50, 189). We quote a fragment.

Five days later, on the occasion of the next experiment, Koko used anything and everything he could lay hand on as a substitute for the familiar stick; the box he merely frequently stared at in a peculiar manner. Suddenly he flew at it and began a violent attack: he was beside himself with rage, flung the box to and fro, and kicked it. These outbreaks which had been rarer on previous days and were considered the result of accumulated ill-humour, were now concentrated entirely on the box. Again and again as he turned from the objective, his eyes sought the box; he glared, and then fell upon it. (P. 45.)

Additional touches to the picture of rage in the nearly mature chimpanzee are supplied by the following paragraph:

Tschego did not throw stones. But when she was scolded, we could sometimes observe her stamping indignantly to and fro, throwing her head backwards and forwards, and not only shaking and clawing with her long arms in the direction of the scolder, but also seizing handfuls of grass and herbs, and tearing at them till the bits were strewn round her. If she had her blanket with her, she dashed it furiously on the ground, but always these gesticulations both physically and psychically, were partially directed towards the enemy, as were also the manipulations of the grass and herbs. One could not yet exactly use the terms "throw at" or "strike at," but the creature was obviously *approaching* the use of a weapon. The excitement which expresses itself by throwing and hitting the movable objects in the ape's vicinity has naturally a tendency towards and against the object of anger. But I think it highly improbable that these *forms of expression* of anger bring up innervations derived from human originals. In such a state of primitive emotional excitement, all not *inherent to the chimpanzee's nature* is certainly completely discarded. The stone-throwing by the younger apes, which we had occasion to experi-

ence at first, also looked more like an explosion of anger than a deliberate attack with a weapon. It is quite in keeping that this explosion should be in the direction of the stranger: he is the "object of emotion." (Köhler, 1925, pp. 90-91.)

References to exhibitions of anger and rage by free wild chimpanzees usually mention sudden, loud, and sometimes prolonged yelling or screaming, menacing bodily attitude if an enemy is at hand and the animal is at bay, drawn lips, exposed teeth, and open mouth, as portrayed for example in the picture of an angry adolescent chimpanzee presented by Yerkes (1925, opposite p. 161). It is not to be doubted that resentment, anger, and rage are among the most common of chimpanzee emotions, and that the category which they represent offers to the psychobiologist rare opportunities for experimental study of varied problems of affectivity.

JOY, PLEASURE, HAPPINESS

In descriptions of chimpanzee behavior it is not unusual to encounter the terms smiling, laughing, joking, humor, mischief, and although we incline to agree with Köhler (1925, pp. 318-319) that the animal neither laughs nor weeps in anything approaching the human sense of these terms, we still are impelled to defend, from the standpoint of general descriptive value, the use of such terms as have been mentioned. For especially in the young chimpanzee it is possible to induce smiles, facial and vocal responses simulating laughter, evidences of good humor, and there are many and varied spontaneous manifestations of mischievousness and enjoyment of practical jokes. Indeed, contentment, satisfaction, pleasure, as for example with environmental conditions, and especially with satisfying food, human or species companionship, and opportunities for amusement and exercise in play, gain pronounced expression in bodily attitude, gesture, facial contour, and specific movements of portions of the body.

For this particular emotional category there are no special contributions. Through the writings of Köhler (1925) and Yerkes (1925) are to be found references to agreeable emotions and their manifestations, but thoroughgoing description is lacking. From

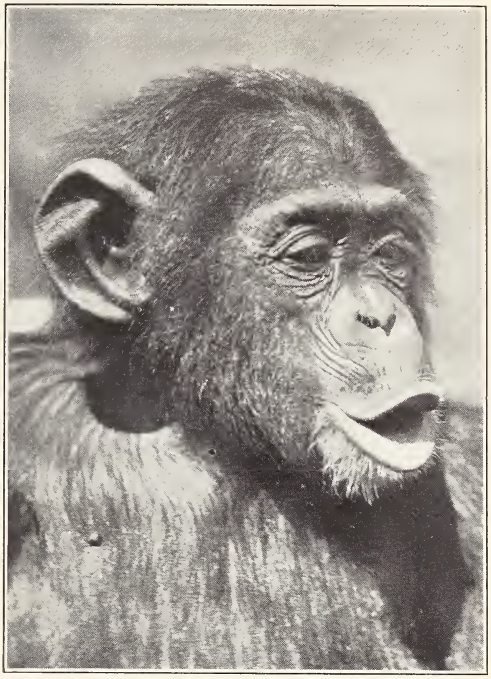


Fig. 101. Greetings! A young chimpanzee expresses interest and excitement. Courtesy of F. W. Bond, photographer, and Zoölogical Society of London.

varied unpublished observations we draw our principal support for the general statement made above, and also for our conclusion that a sense of humor is discoverable in certain individuals, as well as obvious delight in and appreciation of joking or mischief. The latter, although casually referred to by some authors, remains to be established by circumstantial description. We cite as examples of the several references which we have found: Rennie's account (1838, pp. 68-69) of a chimpanzee's practical joke on a carpenter, and Sokolowsky's description of mischievousness. Of a captive this author writes:

Towards the public, on the other hand, the chimpanzee always behaved very shabbily. He took great joy in, so to speak, "wiping out" the human beings who were watching him. If he was in possession of a stick he sought, with arms

stretched out through the netting, to reach one of the visitors by means of the stick and to strike him, which if he succeeded gave him great joy. A trace of mischievousness passed at times over his face. The corners of the mouth would be drawn wide open, the teeth bared, and the eyelids a little closed. His eyes had a glittering expression; one could see from the whole animal that this procedure gave him great joy. He was ready for every kind of mischief. It was one specialty of his to take hats from the heads of the ladies and gentlemen, and as soon as he had succeeded, like lightning to retire into the inside of his cage so that not one of those standing before the cage could get his property again. (Sokolowsky, 1908, p. 69.)

No one who has been long and intimately acquainted with an average or superior specimen of chimpanzee in captivity will question the existence of varied modes of expressing delight, pleasure, and the mood of contentment or happiness. For although in general this animal is mercurial instead of constant and stable, it nevertheless as clearly displays moods which may persist from hour to hour, or even from day to day, as it does transient emotions of fear or anger.

CONFIDENCE, SYMPATHY, AFFECTION

An attitude of trust, friendliness, and even those stronger affections which we should call sympathy and love, may readily be observed in the captive chimpanzee. Expressions of these emotions among themselves, and also toward persons, are unmistakable. Conspicuous among the modes of response which figure in this emotional category are gentle patting or stroking of a chimpanzee or human companion with the hand. This we have frequently observed among the individuals of our colony, and it has appeared also occasionally as an expression of favor or appreciation toward us, as, for example, when an affectionate animal would gently pat the shoulder of his human companion. Another generalized mode of response is describable as snuggling. The animal seeks contact with a fellow-being or perchance places its head against the neck, trunk, or limbs of its human companion. Kissing is commonly observed among captive specimens, which apparently in this respect act toward human beings as toward one another. These are but conspicuous examples of modes of expression, for neither the literature nor our own observations justify us in attempting a complete catalogue.

Most frequently figuring in the literature are indications of sympathetic or affectionate relations between parent and young. The attachment clearly is mutual and the evidences of sympathy are no less impressive than those of dependence on the part of the infant. Du Chaillu (1861, pp. 283-284) supplies a characteristic fragment of description, and somewhat more detailed and useful observations on captive instead of wild specimens are reported by Bingham (1927) in his study of the family life of the chimpanzee.

Inasmuch as expressive acts typified by kissing and hugging, although frequently mentioned by observers, are commonly called in question, we shall take particular pains to cite authorities and to consider evidences in some detail. Of the occurrence of acts to which these terms may appropriately be applied there can be no doubt, but whether they are natural to the chimpanzee or imitations of man is not known.

Recognizing the act of kissing, Rothmann and Teuber (1915, p. 15) suggest as possible explanation the tendency to transfer food from mouth to mouth. This behavior they think may give rise to what eventually comes to simulate closely the human act of kissing. Mention is made of the phenomenon by Heck (1922, p. 670), and Sheak (1923, pp. 51-52) pertinently remarks: "To me one of the most remarkable things about the chimpanzee is the fact that he understands how to express affection and gratitude by hugging and kissing without being taught. . . ." And in description of the act, the chimpanzee kiss "is not a smack of the lips, but a lingering, caressing touch of the lips to the bare neck of the keeper, to his hand, or to his shoulder, and frequently accompanied by a gentle pressure from the teeth." Similarly, Köhler (1925, p. 51) tells of evidences of attachment, and (p. 306)

of gratitude toward a human helper. We have many times observed kissing, hugging, and similar expressions of sympathetic relations in our subjects, but never under such circumstances that we could definitely and certainly eliminate human influence. It is our opinion, however, from such inconclusive data as are available, that these acts are natural to the species, and although probably in varying degrees induced or modified by human behavior, not primarily imitations thereof.

We would conclude this brief discussion with an appropriate word picture from Kearton. It is characteristically vivid, and it also agrees perfectly with our own observations.

We had already travelled over a hundred miles together, and I had grown accustomed to carrying Toto pick-a-back for mile after mile. At first he had clung desperately, clasping his hands under my chin until I was nearly throttled; but gradually I had shown him how to balance with his legs at my waist and hold me lightly by the shoulders. Then we were both comfortable enough, and sometimes I would even forget all about him till he would suddenly lay his head on my shoulder and try softly to kiss my cheek. (Kearton, 1925, p. 44.)

Toward sick or injured companions the chimpanzee frequently exhibits what in ourselves we describe as sympathetic solicitude and tender care. Several times we have had opportunity to observe such attitude and behavior. The following are descriptions of typical instances taken from our own experience.

Expressions of sympathetic emotion, although not lacking, were sometimes difficult of identification. Panzee, for example, would occasionally resent liberties which were taken with Chim and would, as it seemed, come to his defense by attempting to strike or bite anyone who was playing roughly with him. I at first thought that this was an expression of sympathy. Subsequent observations indicate that it was jealousy instead. Similarly, the interpretation of Chim's behavior toward Panzee when both were lonesome, frightened or discouraged by being left behind on a walk, is difficult. Casually observed, his attendance on her at such times and his evident efforts to push or pull her along, and indeed to direct her by placing both hands on her shoulders, or an arm about her waist, suggest sympathetic companionship, but continued observation indicates that his is far from unmixed altruism. It is always difficult to decide to what extent he is directed by selfishness at such times. When timid or fearful he inevitably seeks companionship. His presence beside Panzee, who may happen to be unconsciously sustaining his courage, looks altruistic, and there is no reason to deny the altruistic element, for when Panzee fell behind on our rambles because of her relative weakness, Chim often would respond to her cry of complaint by dropping back to help her forward. I recall once seeing him stand beside her in heroic attitude until the cows gradually approaching were within ten yards of them, when, evidently unable longer to control himself, he deserted her and made a dash for the nearest tree. Perhaps many men would have done likewise.

Expressions by Chim and Panzee of sympathy for persons were abundant. They readily became attached to those whom they saw constantly and learned to trust. Of gentle disposition naturally, they are affectionate and loyal, appreciating kindness and, in case of Chim, at least apparently understanding reasonable discipline and even punishment. (Yerkes and Learned, 1925, pp. 35-36.)

Impressive indeed is the thoughtfulness of the ordinarily care-free and irresponsible little chimpanzee for ill or injured companions. In the Abreu collection there was for a while opportunity to observe the social relations of three individuals whose age certainly was not above five years. In the same cage were a little male and two females, one of the latter mortally ill. She was so ill that much of the time she lay on the floor of the cage in the sunlight, listless and pathetic. There was excellent opportunity to observe the attitude of her lively companions toward this helpless invalid. In all their boisterous play they scrupulously avoided disturbing her, and, in fact, seldom touched her as they climbed, jumped, or ran about the cage. Now and then one or the other would go to her and touch her gently or caress her; or again one of them, fatigued or worsted in some game, would obviously seek refuge and respite by going close to her. In this position safety from disturbance was assured. A certain solicitude, sympathy, and pity, as well as almost human expression of consideration were thus manifested by these little creatures. (Yerkes, 1925, pp. 130-131.)

Nor are evidences of sympathetic relations between chimpanzee and man, expressions of solicitude and affection, lacking. The literature supplies numerous examples; so also does our own experience. But again we choose to take our illustration from the life of Toto.

I have said in the Foreword at the beginning of this narrative that the sympathy between us was

not all on my side, and that Toto at times showed a real sense of understanding when I in my turn needed help and affection. Never did he show this so appealingly as soon after this Christmas, when I was stricken down with a severe attack of fever.

Toto made himself my nurse. He would not leave me. All day he would sit beside me, watching with a care that seemed almost maternal, and anything that I wanted he would bring me. He would go to the medicine chest when I told him to do so, and bring the bottle of quinine, and then he would fetch a glass and water. When I wanted a book he would go to the shelf and stand in front of the eight or ten books that lay on it. He would put his finger on the first and look at me.

"No," I would say, and then he would touch the one at the opposite end of the row.

"No," I would say again, and he would touch all the books in turn till I said "Yes." Then he would bring the book to me.

In the afternoon he would lie down on the bed beside me, put his arm out as if to protect me, and go fast asleep.

When I began to get about again, I felt the heat very much at midday, and would go up to my room and throw myself on the bed, too exhausted even to remove my boots. The first time that this happened I fell asleep at once. When I awoke, I could hardly believe it when I found that my boots had been taken off and put on the ground while I slept. It seemed impossible that Toto could have done this, and done it so quietly that I did not wake. But the next day, directly I lay on the bed, I felt his fingers undoing the laces.

It may be that some who read this book will say that friendship between an ape and a man is absurd, and that Toto, being "only an animal," cannot really have felt the feelings that I attribute to him. Some people may say that. They would not say it if they had felt his tenderness and seen his care as I felt and saw it at that time. He was entirely lovable. (Kearton, 1925, pp. 98-100.)

DEPRESSION, GRIEF, MELANCHOLY

Among the changing moods of captive chimpanzees it is not difficult to identify depression and elation. Conspicuous indeed are hours or days of cheerfulness and those of melancholy. Causes of such moods frequently are difficult to discover, and again they seem obvious: separation from companions, imprisonment in restricted quarters, restriction of opportunity for play, withholding of desired food or drink, or change from a more to a less desired diet, necessity of working for food or freedom in an experiment which makes difficult demands. Any or all of these circumstances may induce depression and cause the individual to act as though utterly disconsolate and discouraged with life. Even more conspicuous as condition of emotions belonging in this category are enforced separation from a habitual companion by reason of illness or death of the latter. Our principal observational data are taken from this type of situation. As we have previously had occasion to remark in connection with other emotional categories, there is almost no significant scientific literature. A single article devoted especially to the description of "grief," because of its uniqueness, we would quote at length.

With the chimpanzee, the evidences of a certain degree of genuine grief were well marked. The two animals had lived together for many months, and were much attached to each other; they were seldom apart and generally had their arms about each other's neck; they never quarreled, even over a pretended display of partiality by their keeper in feeding them, and if occasion required one to be handled with any degree of force, the other was always prepared to do battle in its behalf on the first cry of fright. After the death of the female, which took place early in the morning, the remaining one made many attempts to rouse her, and when he found this to be impossible his rage and grief were painful to witness. Tearing the hair, or rather snatching at the short hair on his head, was always one of his common expressions of extreme anger, and was now largely indulged in, but the ordinary yell of rage which he set up at first, finally changed to a cry which the keeper of the animals assures me he had never heard before, and which would be most nearly represented by *hah-ah-ah-ah-ah,* uttered somewhat under the breath, and with a plaintive sound like a moan. With this he made repeated efforts to arouse her, lifting up her head and hands, pushing her violently and rolling her over. After her body was removed from the cage—a proceeding which he violently opposed—he became more quiet, and remained so as long as his keeper was with him, but catching sight of the body once when the door was opened and again when it was carried past the front of the cage, he became violent, and cried for the rest of the day. The day following, he sat still most of the time and moaned continuously—this gradually passed away, however, and from that time he has only manifested a sense of a change in his surroundings by a more devoted attachment to his keeper, and a longer fit of anger when he leaves him. On these occasions it is curious to observe

that the plaintive cry first heard when the female died, is frequently, though not always made use of, and when present, is heard towards the close of the fit of anger. It may well be that this sound having been specialized as a note of grief, and in this case never having previously been called into use by the occurrence of its proper emotion, now finds expression on the return of even the lesser degree of the same feeling given rise to by the absence of his keeper, and follows the first outbreak of rage in the same manner as the sobbing of a child is the natural sequence of a passionate fit of crying. It may be noted too, that as his attachment to his keeper is evidently stronger than when there was another to divide with him the attention which they received, the grief now caused by the man's absence would naturally be much stronger and a more exact representation of the gestures of grief would be made.

Notwithstanding the intensity of his sorrow at first, it seems sufficiently evident that now a vivid recollection of the nature of the past association is not present. To test this a mirror was placed before him, with the expectation that on seeing a figure so exactly like his lost mate, some of the customary signs of recognition would take place, but even by caressing and pretending to feed the figure in the glass, not a trace of the expected feeling could be excited. In fact, the only visible indication of a change of circumstances is that while the two of them were accustomed to sleep at night in each other's arms on a blanket on the floor, which they moved from place to place to suit their convenience, since the death of the one, the other has invariably slept on a cross-beam at the top of the cage, returning to inherited habit and showing, probably, that the apprehension of unseen dangers has been heightened by his sense of loneliness.

On looking over the field of animal emotion it seems evident that any high degree of permanence in grief of this nature belongs only to man; slight indications of its persistence in memory are visible in some of the higher animals and domesticated races, but in most of them the feeling appears to be excited only by the failure of the inanimate body, while present to the sight, to perform the accustomed actions. (Brown, 1879, pp. 173-175.)

Typical of the reported evidences of grief or sorrow on the death of a companion are the following. Garner, from observation of the behavior of two young chimpanzee companions, one of which died, relates that:

On the morning Moses died, the conduct of Aaron was unlike anything I had observed before. When I approached their snug little house and drew aside the curtain, I found him sitting in one corner of the cage. His face wore a look of concern as if he was aware that something awful had occurred. When I opened the door, he neither moved nor uttered any sound. I do not know whether or not they have any name for death, but they surely know what it is.

Moses was dead. His cold body lay in its usual place, but was entirely covered over with the piece of canvas kept in the cage for bed-clothing. I do not know whether Aaron had covered him up or not, but he seemed to realise the situation. I took him by the hand and lifted him out of the cage, but he was reluctant. I had the body removed and placed on a bench about thirty feet away, in order to dissect and prepare the skin and skeleton to preserve them. When I proceeded to do this, I had Aaron confined to the cage, lest he should annoy and hinder me at the work; but he cried and fretted until he was released. (Garner, 1896, pp. 114-115.)

Strikingly similar to this is a case described by Sheak (1917, p. 305). The surviving animal is said to have insisted on following the body of his companion when it was removed from the cage, and on being prevented to have cried for an hour and continued listless and spiritless for several days.

Instances of similar behavior are described from the Abreu colony by Yerkes (1925, pp. 92-94); and Heck (1922, p. 671) reports unusual evidence, as a chimpanzee approached death, of attachment to its keeper.

That depression, grief, and sorrow are occasionally manifested by the chimpanzee is beyond dispute. Definitely established also is the fact that weeping in the human sense does not occur. The typical approach to it is whining, moaning, or crying in the manner of a person in distress. Tears we have never observed, and in this we are confirmed by statements of Garner (1896, p. 115), Rothmann and Teuber (1915, p. 15), and Köhler (1925, p. 33, footnote).

By various authorities it has been suggested, and by Kohts (1921) definitely stated, that the chimpanzee more closely resembles man affectively than in its intellectual or cognitive life. Appearances we grant are strongly in favor of the Kohts opinion, for emotional expressions are at once more conspicuous, impressive, and more readily assimilated to human experience than are those which are primarily intellectual. It is our opinion, however, that

the facts at present available are too few, and also too imperfectly known, to justify conclusion. From general knowledge of the facts of phylogenesis it might well be inferred and argued that the affective aspect of life is more primitive, and therefore biologically more nearly basic, than the cognitive, and that consequently it is the conspicuous common possession of each type of primate, whereas in the various types, through monkey, anthropoid ape, and man, it has been overlaid, hidden, disguised, modified, and supplemented in varying ways and degrees by the development of intelligence. This point of view, and it is the one which we would tentatively maintain, suggests the opinion that man is distinguished from the chimpanzee primarily in intelligence.

We have concluded our brief and necessarily unsatisfactory survey of affective expression in the chimpanzee. In again characterizing the literature as almost without scientific value, we would restate also our conviction that the affective life of the chimpanzee is a peculiarly important and prospectively fruitful field for systematic naturalistic and experimental inquiries. This is especially true, on the one hand, because through such inquiries fundamental problems of the nature and relations of so-called instinctive behavior are likely to be solved, and, on the other, because since motivation is largely, if not primarily, affective in its relations and implications, problems relating to it necessitate the intensive study of affective experience and its expressions.

CHAPTER TWENTY-FOUR

AFFECTIVE BEHAVIOR OF CHIMPANZEE: VOCALIZATION, SPEECH, LANGUAGE, AND INTERCOMMUNICATION

THE certainty that, in the chimpanzee, vocalization is primarily affective impels us to include its consideration in our chapters on affective behavior. The probability that it is also to an important extent cognitive, adaptive, and imaginal, leads us to place it at the end of our examination of affective behavior as logical transition to description of intelligence. It seemingly is well established that the motor mechanism of voice in this ape is adequate not only to the production of a considerable variety of sounds, but also to definite articulations similar to those of man. To give a historical touch to our treatment of the subject we quote the century-old observations and reflections of Traill, who under the name "Orang Outang" dissected and briefly described the anatomy of the chimpanzee.

> On reviewing the structure of the organs of respiration, of the tongue and larynx, there does not appear any reason why the Orang Outang [chimpanzee] should not speak. The organization, as far as we can judge, seems perfect; yet this animal, according to the best evidence, has never been known to make any attempt at articulate sounds. Indeed, in this respect it seems inferior to several other animals, which have been taught to imitate and repeat words or sentences. If animal organization were alone necessary to speech, the Orang Outang [chimpanzee], from its striking approach to man, ought to possess this faculty in an eminent degree. We must, therefore, refer its deficiency in this respect, not to corporeal, but to mental peculiarities. It would be, perhaps, extremely difficult to point out the exact boundary between human intellect, and the faculties of the lower animals; but one grand distinction peculiar to the human species, is the possession of that intellectual power, by metaphysicians denominated *abstraction.* As the expression of ideas by arbitrary sounds, implies the exercise of this faculty, which does not seem granted to the brute creation, it may not be going too far to conclude, that the want of speech in the Orang and other animals, with a corporeal organization so similar to that of man, is wholly to be attributed to the absence of the faculty of abstraction. (Traill, 1821, pp. 42-43.)

By Giacomini (1897, p. 117) the larynx of the chimpanzee is said to resemble that of man more nearly than does that of any other primate. Grünbaum and Sherrington (1903) report failure to demonstrate presence of speech center. We may not enter into anatomical description, but would refer readers who are particularly concerned with the neuromuscular vocal mechanism to reviews of the literature, references, and original contributions by Keith (1896) and Sonntag (1923 and 1924).

Like the gibbon, the chimpanzee has the reputation of being noisy, while by contrast both the orang-outan and gorilla are silent. The frequent and vigorous vocalization of chimpanzees is repeatedly referred to by travelers, hunters, and naturalists, but no one of them has taken the trouble to enumerate and describe in detail the forms or circumstances of sound production. To cite by way of evidence a few of the many authorities whose names appear in our bibliography, Livingstone (1875, p. 324) speaks of the animals as "giving tongue like foxhounds." Often, he says, they collect together and make a drumming noise, perhaps on hollow trees, and anon they burst forth in loud yells. There is an often quoted passage in Pechuël-Loesche (1882, p. 247) which reads:

> As often as I have hunted them, I have never seen a chimpanzee in the wilderness face to face, although they have often broken through the underbrush close by me, and Dr. Falkenstein has only once seen a young one whisking past. Concerning their life in freedom I can say little, except that their frightful chattering, their screeching and howling, which break out morning and evening and sometimes in the night, make them one of the most hated animals. Since they are true

virtuosi in producing worthless sounds which can be heard afar off, and since also the echo gives these back multiplied, one can not appreciate how much they contribute to the wild uproar; sometimes one seems to hear more than a hundred.

Although one must grant that this author's knowledge seems remote from contact with his subjects, there is no reason to question the reliability of his statements about vocalization, for they are wholly in accord with those of other authorities. Referring to Zenker, Sokolowsky (1908, p. 48) emphasizes the noisiness of this type of great ape and the social relations and significance of its vocalization. Voicing native opinion, Jenks (1911, p. 62) writes: "By day and night the chimpanzee seems always to have something to say, and one even when alone frequently makes noise enough for half a dozen animals."

We quote with unusual satisfaction the words of von Oertzen, because he for a considerable time lived in the country of the chimpanzee and became intimately familiar with wild and captive specimens.

In Akoafim not a night passed in which I did not hear the piercing outcry of a herd of chimpanzees. The gorilla takes his way quietly, the chimpanzee complains and kicks up a row, especially in the morning and evening hours. An old male intones a deep bass ascending Ho-oh-hu-hu, then the whole troop joins in with Ua-ua-ua, the tones swelling to a powerful strength, and then gradually falling away until the frightful concert drops to the call of a single animal. The tones are made not only by exhaling but also by inhaling of the breath. The awakening company sounds its cry while the animals are yet in the nest, then for half an hour longer during the search for food, also at night, especially when the moon shines. I assume that this roaring, frightful racket serves to scare away any enemies. (Von Oertzen, 1913, p. 15.)

The marked contrast between vocal expression in wild and captive specimens has by no one been better described than by Köhler.

Because of the unusual quiet, ready accessibility of food, and consequent lack of need of tramping, climbing, and diligent search for food and water,

the apes in captivity tend to be more passive and quiet than in freedom. Kamerun hunters remark that they missed in the chimpanzees at Tenerife the far-carrying noise which is made by herds of these animals in the bush. Drumming on the stumps of trees and the like may be observed even in captivity, but in nature such sounds may be heard over great distances. (Köhler, 1921a, p. 73.)

We have offered a free, abbreviated translation of Köhler's sentences.

That the character of vocalization differs in accordance with species as well as with age, sex, and individuality, may not be doubted; yet we have failed to discover in the literature other than crude descriptions of the vocal expressions of different types. Du Chaillu long ago stated that:

The cry of the Kooloo-Kamba is very different from that of the *T. calvus* and chimpanzee, resembling the syllables "Kooloo," which I have heard, and from which it derived its name among the natives,—"Kamba" meaning "to speak," among one tribe; other tribes give to the animal only the name of "Kooloo."

This ape was killed by me in the Ashankolo Mountains. As I was returning to our camp I heard the cry of "Kooloo, Kooloo," and asked my guide what it was; he said that it was a kind of "man of the woods," which I had not seen before, called Kooloo-Kamba. (Du Chaillu, 1859-61, p. 360.)

Clearly this observer means to imply that the three types of chimpanzee called by him Kooloo-Kamba, *Troglodytes calvus,* and chimpanzee, have distinctive calls or cries.

Garner makes analogous distinction when in contrasting the vocalizations of the two types of chimpanzee which he designates as "Kulu-Kamba" and "Ntyigo," he says:

One important point in which these two types of ape differ is in the scope and quality of their voices. The *kulu* makes a greater range of vocal sounds. Some of them are soft and musical; but those uttered by the *ntyigo* are fewer in number and harsher in quality. One of these sounds resembles the bark of a dog, and another is a sharp, screaming sound. (Garner, 1900, p. 90.)

SPEECH

We have heard the chimpanzee whine, moan, groan, grunt, bark, shout, yell, hoot, and scream, but never have we felt sure that the term speech could fittingly be applied to such utterances. The literature on this topic is more than usually ample and suggestive of problems, but scientifically it is indeed

far from satisfactory. The most extensive contributions to fact have been made by Garner (1896, 1900), Furness (1916), and Yerkes and Learned (1925), while historical digests and brief systematic discussions are to be found in Yerkes (1925) and Yerkes and Child (1927). We shall present briefly their evidences and conclusions.

From studies of vocalization and speech extending over many years in which from time to time wild or captive chimpanzees were subjects, Garner (1896, p. 64) states that they have several sounds which designate their natural wants. Their vocabulary he estimates as approximately twenty words, many of which are "vague or ambiguous, but they express the concept of the ape with as much precision as it is defined to his mind, and quite distinctly enough for his purpose." It is claimed by Garner that he learned several of the significant sounds or words of the chimpanzee, and in certain instances was able to communicate with an individual or, in other words, make himself understood. Many of the sounds are difficult of human reproduction, nor can they readily be represented by any human system of phonetic symbols. The author attempts by the use of letters and marks of punctuation to represent the several sounds heard by him. Detailed descriptions of the forms of vocalization, together with indication of conditions of appearance and probable meaning, may be found in Garner's books. We present his general conclusions concerning speech in the chimpanzee in his own words.

> It must not be inferred from this small list of words and signs that there is nothing left to learn. So far we have only taken the first step as it were in the study of the speech of apes. As we grow more familiar with their sounds, it becomes less difficult to understand them. I have not been disappointed in what I hoped to learn from these animals. The total number of words in the speech of all simians that I have learned up to this time is about one hundred. I have given no attention of late to the small monkeys, but I shall resume the task at some future day, as it forms a part of the work I have assumed, but all of that is described in a work already published.
>
> In conclusion, I will say that the sounds uttered by these apes have all the characteristics of true speech. The speaker is conscious of the meaning of the sound used, and uses it with the definite purpose of conveying an idea to the one addressed; the sound is always addressed to some definite one, and the speaker usually looks at the one addressed; he regulates the pitch and volume of the voice to suit the condition under which it is used; he knows the value of sound as a medium of thought. These and many other facts show that they are truly speech.
>
> If these apes were placed under domestication, and kept there as long as the dog has been, he would be as far superior to the dog in sagacity as he is by nature above the wild progenitors of the canine race. (Garner, 1896, pp. 74-75.)

Basing his contention on observation of one of Garner's chimpanzee subjects, Gladden (1914) disputes the former's claim that the animal used five words to express "yes, no, want, protest, and satisfaction or contempt," and asserts, with the concurrence of the animal's keeper, that no deliberate use was made of a definite sound to express "a concrete idea" (p. 308).

By the chimpanzees of the Canary Island Anthropoid Station, Rothmann and Teuber noted the use of a considerable variety of sounds, including all of the vowels but especially *o* and *u*. They, however, interpret the vocalizations as purely affective and not in any proper sense describable as speech. Joy is expressed, they say, by repeated *oh's*, the tone of which becomes higher in excitement; a short *oh* commonly serves as a sound of greeting; in something like weeping a deep *u* sound occurs; as warning, a short *oh*, and in fear a high *i* sound. These authors, while disagreeing with the conclusions of Garner, emphasize the fact that the chimpanzee is extraordinarily expressive linguistically. Laughter, weeping, anger, rage, various shades of desire, of disappointment, and of greed, are partially vocalized, but there is slight indication of meaning as contrasted with feeling, and the observers were finally led to conclude that, as means of intercommunication, vocalization is less important and bodily attitude and gesture more important in the chimpanzee than in man (Rothmann and Teuber, 1915, pp. 13-14).

Although Furness (1916) was interested primarily in attempts to teach his anthropoid subjects to articulate and speak, certain of his observations bear on the question of the nature and extent of the spontaneous production of meaningful sounds. He had excellent opportunity to note the sounds made by captive chimpanzees. His descriptions, as well as his conclusions, differ markedly from those of Garner and are in general more nearly in accord with those of other authorities. Already, on page 164, we have quoted his statement that the chimpanzee lacks articulate speech.

The most careful and thoroughgoing direct observational description of the sounds produced by the young chimpanzee is that of Learned. Musical notation is used in representing vocalizations, and the author gives also a list of thirty-two "words or elements of speech" used by one or both of the two subjects of observation. These elements we list below, classified in accordance with the initial sound.

Beginning with the guttural *g: Gak, gahk, gah, gha, ghak, gho, ghoo, ga-ha*. Beginning with the guttural *k*, whispered: *Kah-kah, ko-ko, ku-ku*. Beginning with *k*, vocalized: *Ka-ka, ky-ah, kuoh, kah-hah kah-ha-ha, kuh-huh, kha* (*khah*). Beginning with aspirate: *Ho-oh, ho-wha, whah, who-ah, hŭh*. Beginning with nasals and labials: *Ngak, nghak, nkak, m, vts*. Beginning with vowels: *Ah-oh-ah, ai* (*ie*), *ae, ooh, ue*. (Yerkes and Learned, 1925, pp. 154-156.)

These various sounds, recognized by Learned as meaningful and so described in terms of the circumstances in which they are used, are classified in two major categories, each with subdivisions: (1) Sounds associated with food, (a) waiting for food, and (b) eating; (2) sounds associated with other creatures, (a) behavior with people, and (b) behavior together.

It is Learned's conclusion that:

> Although the young chimpanzee uses significant sounds in considerable number and variety, it does not, in the ordinary and proper meaning of the term, speak. Consequently there is no chimpanzee language, although there certainly is a useful substitute which might readily be developed or transformed into a true language if the animals could be induced to imitate sounds persistently. (Yerkes and Learned, 1925, p. 60.)

From years of intimate contacts with the sound production of the Canary Island group of chimpanzees, Köhler, who has nowhere described in detail phenomena of vocalization, states that the animal commonly exhibits so many phonetic elements that we may not suppose it to lack speech on peripheral phonetic grounds (1921a, p. 75). This we interpret to mean that he believes the chimpanzee possesses a vocal mechanism which is adequate for the production of many, if not all, the sounds which appear in human speech, but that nevertheless, and presumably because of characteristics of its neural development, it does not speak. His position on the latter point is indicated definitely, although with extreme brevity, by the phrase, "for speech is definitely beyond his powers" (1925, p. 81; see also p. 277).

Monboddo (1773, pp. 343-347) emphasized particularly the ability of the anthropoid apes to learn to speak. Neither of them, nor of man, does he assert a natural, innate, or instinctive capacity which tends to exhibit itself independently of individual experience. Obviously the distinction is pertinent between the capacity for natural production of meaningful sounds and ability to learn to produce such sounds or to speak. Such evidences as there are of the latter tendency or capacity we would now exhibit.

There doubtless have been many attempts to teach chimpanzees to imitate human words and phrases. Few, however, have become matters of scientific record, and fewer still are worthy of mention. Garner on occasion tried to teach young captives to articulate words which he considered appropriate to their phonetic ability. He observed the movements of the animals' lips and vocal organs, and proceeded accordingly.

> I selected the word *mamma,* which may almost

be considered a universal word of human speech; the French word *feu,* fire; the German word *wie,* how, and the native Nkami word *nkgwe,* mother. Every day I took him on my lap and tried to induce him to say one or more of these words. For a long time he made no effort to learn them, but after some weeks of persistent labour and a bribe of corned beef, he began to see dimly what I wanted him to do. The native word quoted is very similar to one of the sounds of his own speech, which means "good" or "satisfaction." The vowel element differs in them, and he was not able in the time he was under tuition to change them, but he distinguished them from other words.

In his attempt to say *mamma* he only worked his lips without making any sound, although he really tried to do so, and I believe that in the course of time he would have succeeded. He observed the movement of my lips, and tried to imitate them, but seemed to think that the lips alone produced the sound.

With *feu* he succeeded fairly well, except that the consonant element as he uttered it resembled "v" more than "f," so that the sound was more like *vu* making the u short as in "nut." It was quite as perfect as most people of other tongues ever learn to speak the same word in French, and if it had been uttered in a sentence, any one knowing that language would recognise it as meaning fire.

In his efforts to pronounce *wie* he always gave the vowel element like German "u" with the *umlaut,* but the "w" element was more like the English than the German sound of that letter.

Taking into consideration the fact that he was only a little more than a year old, and was in training less than three months, his progress was all that could have been desired, and vastly more than had been hoped for. Had he lived until this time, it is my belief that he would have mastered these and other words of human speech to the satisfaction of the most exacting linguist. If he had only learned one word in a whole lifetime, he would have shown at least that the race is capable of being improved and elevated in some degree. (Garner, 1896, pp. 96-97.)

One must admit that this author's conclusion, from his somewhat discouraging efforts to teach the chimpanzee Moses to articulate words, seems to be influenced at least as much by wish as by the behavior of the animal.

In a more recent contribution to the discussion of speech in the chimpanzee, Garner to the last consistently defends the ability of this ape to speak in a language of its own, and also, within limits, to learn human linguistic elements.

It has been averred that apes cannot be taught human language because they always inhale in their endeavor to imitate the sounds offered them. The fact is that, when the ape speaks his own language, he by no means utters his sounds by inhalation. He speaks precisely as the human does, with his vocal organs used humanly and with the air ejected thru the glottis. But in attempts to utter human speech by imitation, apes are predisposed to inhale instead of exhale. This, however, is purely because, in attempting to move the lips as they see the teacher to move his, they do not quite grasp the *modus operandi* of what they do naturally when talking on their own account. . . . (Garner, 1910, pp. 522-523.)

It is in this article that he describes the vocal achievements of the chimpanzee Suzie who was subsequently observed also by Gladden (see p. 303).

In an earlier chapter (pp. 164-165) the success of Furness in teaching an orangoutan to reproduce intelligibly certain human sounds has been reported. His efforts were extended to the chimpanzee, and by observation of the natural processes of articulation, and attempts to facilitate the imitation of human sounds by manipulation of the animal's tongue and lips, he tried to get it to reproduce simple sounds. The results, which were almost wholly negative, and his conclusions, Furness has thus summarily stated:

I have tried persistently for five years to teach my surviving chimpanzee pupil to say "mama"; she says it, but very poorly. I think I must honestly say it is a failure. Again and again I have tried by the same method that I used with the orang-utan to teach her to say cup, but to no avail. On the whole I should say that the orang holds out more promise as a conversationalist than does the chimpanzee; it is more patient, less excitable, and seems to take instruction more kindly. (Furness, 1916, p. 285.)

The unique observational opportunities of Kearton, in his traveling association across Africa with a young chimpanzee, produced the following. "Toto did not learn to talk. He would imitate my words and produce sounds to which he attached definite meanings. But I do not claim for him the gift of speech." (Kearton, 1925, p. 14.) Already we have quoted these paragraphs in another connection, and with apologies

for the repetition we desist and refer the reader to page 284.

The results of systematic attempt by Yerkes to teach a highly intelligent chimpanzee to reproduce certain words, and this observer's tentative conclusions concerning vocalization and ability to learn to use meaningful sounds, are presented so briefly in the original report that we doubt our ability to do better than reproduce them.

Vocal reactions are frequent and varied in the young chimpanzee, but speech in the human sense is absent. Although the animals have a sound producing apparatus which presumably is capable of functioning much as does that of man, there is slight, if any, tendency to imitate sounds. Chim and Panzee would imitate many of my acts, but never have I heard them imitate a sound and rarely make a sound peculiarly their own in response to mine. As previously stated, their imitative tendency is as remarkable for its specialization and limitations as for its strength. It seems to be controlled chiefly by visual stimuli. Things which are seen tend to be imitated or reproduced. What is heard is not reproduced. Obviously an animal which lacks the tendency to reinstate auditory stimuli—in other words to imitate sounds—cannot reasonably be expected to talk. The human infant exhibits this tendency to a remarkable degree. So also does the parrot. If the imitative tendency of the parrot could be coupled with the quality of intelligence of the chimpanzee, the latter undoubtedly could speak. For, as already pointed out, it possesses a vocal mechanism comparable with that of man, and also a type and degree of intelligence which would enable it to utilize sounds effectively for purposes of speech.

Chim and Panzee, with excellent voices and ability to produce a wide range and a great variety of sounds, yet exhibit only a few types of vocal reaction. Certain sounds, it is true, are characteristic of certain situations, as for example, situations or objects which are desired or liked, disliked or resented, avoided or feared, and so on. Our observations of the animals' vocal reactions, our descriptions of them, and our attempts to interpret them, constitute the materials for the remainder of this volume. It is my final task to tell of systematic efforts to teach Chim to speak.

After short acquaintance with the animal I concluded that he would be an unusually good subject for speech tests. Plans were therefore formulated for systematic training.

Thus far during the past eight months, four methods of speech instruction have been tried, and each in turn abandoned because of lack of positive results.

In one wall of the observation room at Franklin, New Hampshire, a small hole was cut to permit pieces of banana to be delivered through a chute to a small receiving table in the observation room. My thought was that the experimenter by going to this hole from time to time and making such a sound as "bă, bă" in response to which pieces of banana would appear on the table, might not only attract the attention of Chim to the relation of the sound to the much desired fruit, but stir him to attempt to make the sound on his own account.

Once or twice a day for a period of some two weeks this training test was conducted. Chim, at first greatly interested in the performance and eager to get pieces of banana, gradually lost interest in everything except the food. He made no attempt to reproduce the sound and the method was finally abandoned as unsatisfactory.

Some weeks later a box was constructed in which pieces of banana could be held ready for delivery on a little shelf or table at the base of apparatus. This mechanism was arranged so that it could be hung on the wall of the animal's cage and operated at will by the experimenter. Each day at a stated hour the observer would place the apparatus in position, having loaded it in advance with six pieces of banana each about an inch in length, and would call Chim to attention. With him beside the apparatus and watching intently, the sound "cō, cō" was made distinctly and emphatically a few times, whereupon a piece of banana suddenly appeared on the table. Sometimes Chim was allowed to have the banana, and again the experimenter took it in order to continue his interest and attention, and if possible increase his eagerness for the reward. Occasionally this procedure induced certain lip movements seemingly in imitation of those of the experimenter. Rarely, and as if by accident, Chim would make a sound. Certain slight and unconvincing intimations of attempts to make sounds when facing this apparatus appeared. The training test was continued for several weeks with regularity but, apart from the above encouraging signs, with negative results.

Another type of device consisted of a board on which was a small box hinged on one side and provided with a spring which when released would raise the box and uncover a banana. This box had a wire mesh cover through which Chim could see the banana.

Having placed a banana in the apparatus the experimenter would take it into the cage and having secured Chim's attention, would make the sound "nă, nă" distinctly and emphatically a few times, thereupon releasing the apparatus so that the banana was uncovered. Usually the observer seized the banana and began to eat it, thus intensifying the eagerness of the animal. In the second or third trial Chim was allowed to get the banana and eat it whether or not he made a sound. This method also, although tried until the interest of the

animal practically disappeared, yielded wholly negative results.

The experimenter succeeded in training him to speak for food as a dog may readily be taught to do. This he did, however, not in imitation of the trainer but to secure the food.

Throughout the period of observation effort was continually made to interest Chim in human speech and in the production of sounds. He was talked to a great deal and naturally learned to respond properly to certain sounds or if not to the sounds alone, to the situations which they accompanied. Occasionally he seemed to try to talk when persons were talking in his presence.

Although superficially considered these speech training tests are discouraging they have served to throw valuable light on certain of the characteristics of the chimpanzee and have made possible the formulation of problems which are well worth experimental attack. (Yerkes and Learned, 1925, pp. 53-56.)

Evidently, despite possession of a vocal mechanism which closely resembles the human, and tendency to produce sounds which vary greatly in quality and intensity, the chimpanzee has surprisingly little tendency to reproduce other of the sounds which it hears than those characteristic of the species, and very limited ability to learn to use new sounds either affectively or ideationally.

With ability to understand sounds and to react appropriately, the case is far different, for the evidence is abundant and convincing that much that the captive chimpanzee hears from human lips is meaningful and may under favorable circumstances acquire association with appropriate response. We shall cite several of the more important contributions to this particular aspect of the problem of speech.

The comparative psychologist Romanes at one time interested himself in certain experiments with a chimpanzee in London. As evidence of the creature's high order of intelligence he especially mentions the understanding of spoken language and ability to respond appropriately to commands. Although his observations bear as directly and as importantly on the problem of adaptation as on that of ability to understand human speech, we here report his principal results in his own words.

This [intelligence], [he says], is conspicuously displayed by the remarkable degree in which she is able to understand the meaning of spoken language—a degree which is fully equal to that presented by an infant a few months before emerging from infancy, and therefore higher than that which is presented by any brute, so far at least as I have met with any evidence to show. Nevertheless, the only attempts that she makes by way of vocal response are three peculiar grunting noises—one indicative of assent or affirmation, another (very closely resembling the first) of dissent or negation, and the third (quite different from the other two) of thanks or recognition of favours. In disposition she is somewhat capricious, though on the whole good-humoured, fond of her keepers, and apparently never tired of a kind of bantering play which off and on they keep up with her continually. By vocalizing in a peculiar monotone (imitative of the beginning of her own "song"), they are usually able to excite her into the performance of a remarkable series of actions. First she shoots out her lips into the well-known tubular forms (depicted in Darwin's *Expression of the Emotions*, p. 141), while at the same time she sings a strange howling note, interrupted at regular intervals: these, however, rapidly become shorter and shorter, while the vocalization becomes louder and louder, winding up to a climax of shrieks and yells, sometimes accompanied with a drumming of the hind feet and a vigorous shaking of the network which constitutes her cage. The whole performance ends with a few grunts.

A year or two ago it occurred to me that I might try some psychological experiments on the intelligence of this animal. . . .

Having enlisted the intelligent coöperation of the keepers, I requested them to ask the ape repeatedly for one straw, two straws, or three straws. These she was to pick up and hand out from among the litter in her cage. No constant order was to be observed in making these requests, but whenever she handed a number not asked for, her offer was to be refused, while if she gave the proper number her offer was to be accepted, and she was to receive a piece of fruit as payment. In this way the ape was eventually taught to associate these three numbers with their names. Lastly, if two straws or three straws were demanded, she was taught to hold one straw or two straws in her mouth until she had picked up the remaining straw, and then to hand the two straws or the three straws together. This prevented any possible error arising from her interpretation of vocal tones —an error which might well have arisen if each straw had been asked for separately. (Romanes, 1889a, pp. 316-318.)

Up to five straws this experiment succeeded.

We should not wish the reader to infer

that we are convinced of the reliability of the Romanes observations. Evidently the experimental work was done without the ordinary precautions and controls, and it is entirely probable that secondary cues influenced the subject. Nor are we particularly impressed by Romanes' statement concerning the understanding of language, for his position is weak from lack of supporting evidence.

For a young captive specimen of "Kulu-Kamba" called Suzie, Garner reports understanding of some twenty-five words and phrases which he enumerates. The list includes such commands as "Go away!" "Take your cup!" "Quick!" "Wait!" "Drink!" "Shake hands!" "This lingual teaching has been accomplished within six months, altho I devoted no special time to the teaching of any particular thing." (Garner, 1910, p. 522.)

And referring to the same specimen, Gladden reports ability to respond to forty-three commands, in which eighty-one words appear. Of the commands he says thirty-six were usually given without accompanying gesture. He also lists the commands which were used. They are typified by: "Stand!" "Take hat!" "Telephone!" "Turn on the water!" "Light match!" "Spank dolly!" (1914, p. 309.)

By the use of wooden forms Furness taught a chimpanzee the letters of the alphabet from A to M. By name, as contrasted with shape, the animal is said not to distinguish them easily, "except where the letter sound is very distinct: B, F, H, L, M seem to be easy for her to recognize whereas A, K, E, D, C, G are confusing. When asked for the letter I she is apt to mistake it for her eye to which she points. When the letters are drawn the same size and width with chalk on a blackboard or printed in black on white cards she fails to recognize them." (Furness, 1916, p. 286.) And by way of generalization, this observer adds:

> As to a comprehension of the connection of spoken words with objects and actions, both the orang-utan and chimpanzee, I think, exceed any of our domestic animals; both of my anthropoids have been able to understand what is said to them, more intelligently than any professionally trained animals I have ever seen. (P. 285.)

It is a matter of common observation among zoölogical-garden "keepers" and also among the trainers of chimpanzees, that their charges learn not only to obey many commands, but also to understand in a measure many other things that they hear. Sheak (1917, pp. 309-310) reports two tests of understanding of oral command without accompanying gesture. In one case the subject was commanded to put on its hat, in the other to hand the trainer a cup. The orders were obeyed. Such instances seem of trivial importance, but when multiplied a hundredfold, as might readily be done by adding to recorded observations those which hold conspicuous place in the memory of observers, they become significant.

In the Abreu colony it is obvious that many of the chimpanzees attach meaning to various words and phrases which designate objects and acts. There is no record available, but Madam Abreu herself is entirely certain that her charges in varying degrees understand much that she says to them (see Yerkes, 1925, pp. 165 ff.).

Thus far we have considered only the ability of the chimpanzee to understand human speech or its elements. Equally important is the evidence of intercommunication. In another connection (p. 279) we have quoted Köhler to the effect that no less through bodily attitude, pose, and gesture, than through vocalization, chimpanzees understand one another. Here, we would again mention the observations of Rothmann and Teuber (1915) and their wholly pertinent and we believe correct conclusion that other modes of expression are of even greater importance in intercommunication than is vocalization. Relevant also is Passemard's (1927, p. 248) description of intercommunicational behavior antecedent to cooperative action, as quoted on page 371.

It would indeed be difficult to exaggerate the practical importance of attitude, pantomime, gesture, and other forms of behav-

ioral symbolism in the daily life of the chimpanzee. The literature abounds in examples of such forms of linguistic behavior. Köhler, for instance, taught certain of his subjects to point to a desired object, food-containing box, and to tap it in indication of decision that it contained something they wished to have (1918, p. 41). And the same author mentions in various of his works, hand grasping, movements of the head, arms, and extremities, as additional instances of gesture language. In our own subjects we have observed not only such activities as this author specifically mentions, but also forms of bodily contact and a considerable variety of limb and extremity poses and movements. Some of these we have described (Yerkes and Learned, 1925, p. 32, e.g.), but the major part of our observations are unpublished. We would especially emphasize the conspicuousness of such forms of behavior, their importance for our understanding of the mental life of chimpanzees, and the suggestion that if a language can be developed by them it is more likely to be constituted of visual or kinaesthetic than of auditory elements.

The varied materials which we have had at command and which we have critically reëxamined and evaluated, justify, we believe, the statement which we have made elsewhere in response to the question, Do the apes speak? We should, however, in this connection substitute the word chimpanzee for ape.

> Everything seems to indicate that their vocalizations do not constitute true language, in the sense in which Boutan uses the term. Apparently the sounds are primarily innate emotional expressions. This is surprising in view of the evidence that they have ideas, and may on occasion act with insight. We may not safely assume that they have nothing but feelings to express, or even that their word-like sounds always lack ideational meaning. Perhaps the chief reason for the ape's failure to develop speech is the absence of a tendency to imitate sounds. Seeing strongly stimulates to imitation; but hearing seems to have no such effect. I am inclined to conclude from the various evidences that the great apes have plenty to talk about, but no gift for the use of sounds to represent individual, as contrasted with racial, feelings or ideas. Perhaps they can be taught to use their fingers, somewhat as does the deaf and dumb person, and thus helped to acquire a simple, nonvocal, "sign language." (Yerkes, 1925, pp. 179-180.)

Speechlessness notwithstanding, intercommunication is highly complex and useful in the chimpanzee.

CHAPTER TWENTY-FIVE

NERVOUS SYSTEM AND RECEPTIVITY OF CHIMPANZEE

OFTEN contrasted with the life of feeling (affection) is that of sensibility and intellection. They are apparently at one time different forms and again different aspects of awareness. Doubtless we frequently do violence to the facts by divorcing the one from the other in description. Yet separate consideration of these two supremely important forms or aspects of experience and behavior often is logically necessary and practically desirable. We have found such to be the case in this work. Having, then, in previous chapters assembled available data on the life of feeling and its behavioral expressions, we would offer in the remaining chapters on the chimpanzee: first, an account of its sensory and perceptual relations to environment, and second, similar description of aspects of intellection and adaptation. The task promises to be more agreeable than in case of the gibbon and orang-outan, because in this instance much is known concerning receptivity and adaptivity.

BRAIN

SINCE the experiential and behavioral phenomena which we purpose to consider are manifestly dependent on the functioning of the central nervous system and its receptors, conductors, and effectors, it is appropriate to consider briefly the status of knowledge of these structures in the chimpanzee, and also to inquire whether in this instance neurology has been developed to an extent which renders it conspicuously useful to the psychobiologist. Prior to the appearance of the contribution of Tilney (1928) our answer to this question would have been a qualified no; now it is a similarly qualified yes.

As previously, and in accordance with the principle which we have attempted to follow consistently throughout this work, we shall eschew, in favor of our special task, attempt to describe the nervous system and shall present merely certain general statements and references to preëminently important informational sources and bibliographies.

From the time of Traill, who in 1821 (pp. 33-37) in a few sentences described characteristic features of the brain and nerves of the chimpanzee, the marked similarity of this primate's nervous system to that of man has been recognized. But at the same time it has been assumed that the brain of the gorilla is even more like that of man. Prevalent opinion is thus expressed by Sonntag:

> The brain [of the chimpanzee] is larger than that in the Orang, and smaller than that in the Gorilla. The characters are very variable, and it is only by examining many specimens that one can come to the conclusion that the Gorilla's brain most approaches that of Man. (1924, p. 288.)

The cerebral coefficients supplied by Mollison (1914-15, p. 394), and presented on our page 167, are contradictory of the prevalent morphological opinion, since they indicate as order of decreasing magnitude: orang-outan, chimpanzee, gorilla. As the results of studies in structural and functional neurology, behavior, and comparative psychology are examined, numerous contradictions become apparent. Tilney (1928), it is true, strongly supports on morphological grounds prevalent opinion. Nevertheless it must be admitted that it is by no means definitely established that the brain of the gorilla, in its finer structure and functions, most closely resembles that of man. Our own behavioral observations suggest rather that the chimpanzee may rank above it.

Concerning the brain of the chimpanzee Tilney remarks that it is larger than that of

the orang-outan, smaller than that of gorilla, and of its configuration:

The pattern and appearance of the cerebral hemisphere in the chimpanzee may be said to be that of a human brain in miniature. With a few notable exceptions, the convolutional design of this anthropoid corresponds closely to that of man, and might easily be mistaken for the latter were it not for its diminutive size, actually being about one-quarter the volume of the human brain. The characterization of the chimpanzee's hemisphere as a human miniature applies equally to the other two great anthropoid apes. The chimpanzee, however, does retain marks of its inherent primitiveness which are considerably more pronounced than in the case of the gorilla, although less defined than in the orang. A careful comparison of all the markings on the surfaces of the endbrain and the brain stem would almost certainly place the chimpanzee below the gorilla and somewhat above the orang-outang. (Tilney, 1928, II, 567.)

And of the cerebellum this author states that both in form and dimensions it seems to be intermediate between that of man and gorilla, on the one hand, and of the higher monkeys, on the other (p. 571). Unhesitatingly Tilney ranks the chimpanzee between orang-outan and gorilla in humanoid characters of brain.

Keith (1896, pp. 250-251) offers a convenient synopsis of the neurology of the chimpanzee and a bibliography. In other of his publications (1895, 1899) may be found data on growth, volume, and weight of the brain in chimpanzee and comparisons with gorilla. Following in the path broken by Keith, but with less accuracy, skill, and insight, Sonntag gives a brief account of the structure of the nervous system (1923, pp. 402-418), and elsewhere a synopsis and extensive bibliography (1924, pp. 273 ff., especially pp. 281, 288). The latter serves as bibliographic source to the year 1923, and the work of Tilney (1928) to date.

Among the few notable contributions to the functional neurology of the chimpanzee and of obvious importance to the psychobiologist are the experimental studies of the motor cortex by Grünbaum and Sherrington (1903) and by Leyton and Sherrington (1917). Pertinent are the following observations and reflections of these investigators:

Owing to their lesser remoteness from human type it seems more possible in regard to the anthropoid than to monkeys such as macaque to infer the animal's mental attitude at various times. A point which impressed us repeatedly was the seeming entire ignorance on the part of the animal, on its awakening from an ablation-experiment, of any disability precluding its performance of its willed acts as usual. Surprise at the failure of the limb to execute what it intended seemed the animal's mental attitude, and not merely for the first few minutes, but for many hours. It was often many hours before repeated and various failures to execute ordinary acts contributory to climbing, feeding, etc., seemed to impress gradually upon the animal that the limb was no longer to be relied upon for its usual services. The impression given us was that the forerunning idea of the action intended was present and as definitely and promptly developed as usual. All the other parts of the motor behaviour in the trains of action coming under observation seemed accurate and unimpeded except for the rôle, as executant, of the particular limb whose motor cortex was injured. And there seemed to be, and to persist for some time, a mental attitude of surprise at the want of fulfilment of that part of an act which had been expected to occur as usual. The surprise seemed to argue unfulfilled expectation, and defect in the motor execution rather than in the mental execution of the act, raising the question whether the function of part of the cortex ablated in such cases be not indeed infra-mental. (Leyton and Sherrington, 1917, p. 206.)

The highly generalized, inferential, and interpretative accounts of the functional significance of the primate nervous system offered by G. Elliot Smith (1924, pp. 135-154) and F. Wood Jones (1916, pp. 149-195), if considered solely from the vantage point of present knowledge of the functional neurology and psychobiology of the anthropoid apes, appear to transcend observationally established fact. Their discussions, however, are crowded with suggestions and also with question-provoking assertions, and the reader will not readily mistake them for primary sources of fact.

Before passing from consideration of the structure of the nervous system to phenomena of sensory life, we should exhibit present knowledge of the structure of re-

ceptive mechanisms. As reference sources we have discovered no more satisfactory authorities than Keith and Sonntag, previously cited. Nor have we found detailed and otherwise serviceable structural descriptions of any of the chief types of sense organ whose presence in the chimpanzee is recognized, such as the eye, ear, organs of touch, smell, and taste. Doubtless several other varieties exist, but they have thus far failed of identification. It seems strange, as one considers the biological prominence of the chimpanzee, that its receptors should not have been described accurately and in detail as in case of the corresponding human structures.

THE SENSES

Except for the sense of sight, there exists no strictly scientific literature on receptivity and sensibility in the chimpanzee. Mention of one or another mode of sense appears in several publications, but these descriptive statements are casual, vague, impressionistic, and in most instances almost valueless. We cite below a few examples, partly for historical reasons and partly to indicate the transition from the nonscientific status of work to the approximately scientific.

In Traill's account of the chimpanzee (1821, pp. 38-39) is to be found crude description of certain receptors, but no suggestion of the rôle of these structures in the life of the organism. By contrast, Warwick (1832, p. 307) offers trivial evidence of the utility of sight and smell, and Broderip (1835, p. 161) offers a typical bit of description as evidence of sensibility. We present the facts.

Broderip presented to a young captive animal, in turn, his ungloved hand with a ring on one finger and a gloved hand. The specimen, Tommy, examined these objects with interest and thoroughness.

> His sight and his ordinary touch seemed to satisfy him in the case of a natural surface, but, as it appeared to me, he required something more to assure his senses when an artificial surface [the glove] was presented to him; and then he applied the test of his teeth.

The observer might naturally have concluded his description with the inferential statement that the senses of sight, touch, smell, and taste served as examining agencies.

Precisely such contributions to knowledge of the sensory life appear throughout the literature. They suggest, but certainly do not prove, that the chimpanzee is equipped with modes of sense similar to the human, and in a few instances they seem to justify the surmise that one or other of these modes is at least as acute as in man.

It will be recalled from our previous reference in connection with the senses of the gibbon (p. 82) that Pocock (1905, p. 180) infers from the large size of the external ear in the chimpanzee and gibbon that the sense of hearing is probably more acute than in case of the smaller-eared and also more retiring and sedentary orang-outan and gorilla. This author even suggests that size of the ear and corresponding importance of the sense of hearing are correlated with timidity. Of course, apart from other and more definitely established evidence concerning hearing, we may not safely accept Pocock's suggestion nor, indeed, even suspect that this mode of sense is more highly developed in the chimpanzee than in the orang-outan or gorilla.

The Canary Island Anthropoid Station enabled Rothmann and Teuber (1915, pp. 10-11) to make far more important contribution to characterization of the senses of the chimpanzee than had previously appeared in the literature. Yet even this must be considered preparatory to scientific inquiry. These authors characterize sight and hearing as particularly keen, smell as more useful if not also more highly developed than in man, taste as undoubtedly well developed, and touch as very extensively employed in the examination and investigation of environment. One gathers the impression from this contribution, and also from the publications of Köhler which subsequently appeared as a result of work in the same station, that the sensory equipment of this great ape is in general strikingly like the

human, although it may in certain definite respects differ significantly therefrom. The authors, as well-trained investigators, write guardedly, conservatively, and with discreet reservations, except as they have in their possession reasonably definite and reliable data of direct observation. It happens that Rothmann and Teuber obtained relatively few such data, whereas Köhler, as will later appear, gathered an unprecedentedly important assemblage of observations as his contribution to this particular aspect of the life of the chimpanzee.

Belonging in this general characterization of chimpanzee sensibility is the following impression by Kearton of the importance of sight and hearing in his specimen Toto.

He was also helpful in other ways. His eyesight was far sharper than that of a man, and he proved himself an excellent scout. My own eyes are accustomed to the jungle, and I do not often need field-glasses to find the animals which I then stalk until I am near enough to use the camera. But Toto's eyes were far surer than mine, and often he would give me warning and show me the direction to take.

Once while we were out together Toto and I were resting under a little bush near some rocks. Before sitting down I had, as I thought, made sure that there was nothing within sight that I wanted to photograph, so that I could rest without fear of missing valuable opportunities. Suddenly Toto stood upright, thumping his chest excitedly, and turning to me with a little grunt, as if to say, "Be careful! Be careful!" But I could see nothing. I examined every inch of the grass in front of us, but nothing was visible. I took my glasses and studied the ground ahead more thoroughly. Then, fully one hundred and fifty yards away, I saw four tiny dark specks just showing above the grass. They were the tips of the horns of a pair of deer.

In the jungle Toto was always on the alert. Probably he had learnt caution from the dangers of life in his world of the tree-tops, when often a young monkey who strayed carelessly on the ground would disappear for ever. Toto was suspicious of everything that he did not know for certain to be friendly. (Kearton, 1925, pp. 33-35.)

What modes of sense Toto depended upon for detection of the hidden lion (see quotation, p. 288) in the adventure which Kearton has so vividly described, we do not know. It may naturally be inferred that sight, hearing, and smell contributed.

Comparable with the statements of Kearton, because based upon general observation of young specimens, are those of Yerkes and Learned.

I have not given special attention to problems of sensibility in Chim and Panzee and the following statements are only roughly descriptive of the animals' equipment. Undoubtedly the sensory equipment of Chim and Panzee was excellent and in general comparable in usefulness to that of the normal man. Vision is clearly the dominant sense. Smell is used frequently and effectively as a guiding sense, especially in locating and testing foods. Touch, taste, and kinesthetic sensibility are also important.

The use of vision, ever impressive, varied greatly from time to time and with the two individuals. Chim, always alert and interested in everything within the reach of his senses, seemed never to tire of watching objects. Panzee, on the contrary, seemed indifferent to most aspects of her varied surroundings. When riding in an automobile Chim would sit up at attention almost continuously, looking at objects both near and distant and taking keen interest and satisfaction in appearances and happenings about him. Panzee was more likely to attend only to unusual appearances or events and to those which for one reason or another compelled interest or action. Similarly in case of distant vision, Chim was interested, Panzee was not. He has repeatedly been seen to gaze intently from the hilltop pasture into the river valley or to the distant mountains. (Yerkes and Learned, 1925, p. 38.)

A highly generalized account of the senses of the anthropoid apes, based on recorded facts as well as the unpublished observations of the writer, may be found in the description of the Abreu primate colony (Yerkes, 1925, pp. 98-100).

At this point one might justly observe that knowledge of the senses or of receptivity and its behavioral correlates in the chimpanzee is discouragingly vague and inadequate as basis for guidance in the experimental study of social relations, adaptations, and other aspects of life. This is our conviction, but we also are convinced that it would be entirely unfair to the facts to leave the reader with this unalleviated impression, for it happens that in the case of vision certain really admirable experimental studies have provided additional and invaluable information. We propose,

therefore, in the following pages, to examine systematically and in order, the principal modes of sense, beginning with vision and continuing through hearing, touch and temperature sensitivity, smell and taste, to pain and other specific forms of discomfort.

COLOR VISION

By varied evidence the primacy of vision in the life of the chimpanzee is indicated. It is commonly assumed that chromatic as well as nonchromatic vision exists and that there is marked ability to perceive and discriminate size and form. But critical examination of the literature shows that the existence of these visual and perceptual capacities has been established during the last decade. Of general interest are the questions: Can the chimpanzee see and react to colors? Is its color vision like that of man? Taking our cue from this, we shall examine first the studies of chromatic vision.

In the early writers frequently appear remarks about interest in colors and tendency to use colored objects for decorative purposes or for play. Typical of these observations is the statement of Warwick (1832, p. 307): "The Chimpanzee, in particular, was attracted by the brilliancy of colours, always getting up on the approach of any female whose dress was distinguished by the gaiety of its hues."

Evidently such descriptive statements have little value and no bearing whatever on the problem of the existence of color vision, since reaction may have been caused by other forms or aspects of visual stimulation than that resulting from wave length of light. We therefore pass immediately to the consideration of efforts to demonstrate experimentally either the presence or the absence of chromatic vision.

Effort was made by Romanes to test, in the London captive Sally, ability to discriminate colors and to associate certain sounds with colored objects. His own description of procedure and results is ideally clear, concise, and quotable.

> The only other direction in which I have thus far subjected the Chimpanzee to psychological experiment has been in that of attempting to teach her the names of colours. It appeared to me that if I could once succeed in getting her thoroughly well to know the names of black, white, red, green, or blue, a possible basis might have been laid for many further experiments wherein these five colours could have been used as signs of artificially associated ideas. The result, however, of attempting to teach her the names of colours has been so uniformly negative, that I am disposed to think the animal must be colour-blind. It is perhaps desirable to state the facts which have led me to entertain this their most probable interpretation.
>
> The method adopted in these experiments was to obtain from the importers of oriental matting a number of brightly and uniformly coloured pieces of straw—each piece being either white, black, red, green, or blue. Offered the straws two by two of different colours on each occasion, the ape was invited to select the straw of the colour named from the one whose colour was not named, and, of course, on choosing correctly was rewarded with a piece of fruit. In this way she quickly learnt to distinguish between the white straws and the straws of any other colour; but she never could be taught to go further. Now the distinction between the white straws and the straws of any other colour is a distinction which can be drawn by an eye that is colour-blind; and from the fact that the ape is always able to perceive this distinction (she will search long and patiently for a straw of any colour when told that it occurs somewhere in the general litter of white straws constituting her bed, and eventually pick it out), while she cannot be taught to distinguish any of the others, I conclude that her failure in this respect is not due to any want of intelligence, but to some deficiency in her powers of colour-perception. (Romanes, 1889a, pp. 320-321.)

Without indicating the nature of the evidence on which he bases the conclusion, Keith (1899, p. 298) reports of the captive called Johanna that "she appears to be colour-blind." Naturally neither the statement of Keith nor the results of Romanes may be accepted as conclusive.

With a young chimpanzee Garner (1900, p. 139) made certain tests of color vision which convinced him that colors could readily be distinguished "if the shades were pronounced." His observations are incidental and insignificant, whereas by contrast those of Furness, who employed colored blocks and ribbons, are worthy of serious consideration. As much because of its methodological significance as its results we recommend the rereading of our pertinent

quotation on page 173 as introduction to the following:

> When the chimpanzee knew the three colors [red, blue, and yellow] distinctly both by name and by sight a new set of twenty-four was given to her, but this time there were four each of violet, blue, green, yellow, orange and red. It was decidedly unexpected to find that she readily appreciated the difference of these new tints and at the end of the first lesson was able to build up all the blocks in separate colors, although the tone of coloring of the green and the blue, and the yellow and the orange were very much the same. My chimpanzee, at least, has an appreciation of color distinct from tone. (Furness, 1916, pp. 288-289.)

Mention has been made of these several naturalistic and experimental observations chiefly to exhibit the contradictoriness and inconclusiveness of results. We may safely assert that up to 1916 the existence of color vision in the chimpanzee had not been definitely proved, because in any or all of the experiments reported, brightness or intensity of the stimulus, instead of hue, may have determined the response.

We now turn to more thoroughgoing investigations. Köhler (1918), in the Canary Island Anthropoid Station, with the precautions of a trained observer and experimentalist, studied the behavior of the chimpanzee in relation to chromatic stimuli. Circumstances unfortunately precluded the use of spectral lights and also of standardized colored papers as stimuli. But undaunted by these difficulties and disadvantages, the investigator prepared red, blue, and yellow pigmented surfaces, the light from which he describes as highly saturated. Resources were lacking to measure either the range of wave lengths or the energy-values of the stimuli used.

The three colors named above were used in pairs, and intermediate hues were obtained by means of an electrically actuated color mixer. Thus, for example, for the first series of experiments, the following pairs of stimuli were obtained by utilization of blue, red, and mixtures thereof: Stimulus A consisted of 360° of blue; B, 270° blue + 90° red; C, 200° blue + 160° red; D, 100° blue + 260° red; E, 30° blue + 330° red (1918, p. 65). With this series of chromatic stimuli it was possible for the investigator to present to a subject for discrimination and choice, pairs of colors ranging from blue, through several intermediate hues, to red.

The procedure of experimentation was essentially as follows. On a table two similar wooden boxes were placed. In the front of each box there had been cut a circular window. Behind each window a color mixer was located to provide chromatic stimulus. In each case the stimulus area was approximately ten centimeters in diameter, and the distance between centers of stimulus areas was eighteen centimeters. In each box, back of the color mixer and completely hidden from the subject, was a food receptacle. In any given experiment one of these receptacles contained food and the other was empty. The food-containing receptacle was associated with what is designated as the positive stimulus—the one to be chosen by the animal in order that the food may be obtained as reward—whereas the empty receptacle was associated with the negative stimulus.

The chimpanzee subject, in accordance with previous training in similar forms of experiment, was required to indicate choice of the one or the other color by pointing to it with a stick or by laying the stick upon the box which contained the positive color. Naturally the animal was so placed in relation to the table and boxes that it could not reach them with its hands but must of necessity indicate its response by use of the stick.

Four chimpanzees were used as subjects in these color-vision experiments. Two were tested with blue, red, and mixtures thereof, and the other two with yellow and red or mixtures thereof. The conditions in the several experiments were varied somewhat, since it was the purpose of the investigator to study other aspects of response in addition to those included in color vision.

The first subject observed failed after two hundred and fifty experiments, which extended over fourteen days, to discrimi-

nate between stimuli B and C (blue-red and red-blue) and consistently to choose C, the dark red color, in order to obtain the reward. Evidently baffled and discouraged the animal worked complainingly and unwillingly. Finally she adopted a method of response which rendered continuation of work useless. Quickly and without observation or endeavor to discriminate and select the positive stimulus, she would place the stick on one of the boxes, usually the one at her left. Köhler adds that in subsequent experiments this animal usually exhibited marked preference for the stimulus at her left whenever she was baffled or found it peculiarly difficult to discriminate (1918, p. 67).

On the assumption that the colors were too nearly alike for easy discrimination and choice, stimulus D was substituted for C. Almost immediately, states Köhler, correct response appeared, and in the first fifteen experiments only four mistakes occurred.

Having thus demonstrated discrimination of these two chromatic stimuli, the investigator, in order to exclude the possibility of choice by brightness instead of by hue, reversed the brightness relations. Previously D had been the brighter; now B was rendered so. Despite this change the subject continued to choose D correctly (p. 69).

Subsequently several other pairs of stimuli were tested and the work was extended to a second subject, with the final result that Köhler satisfied himself of the presence of red-blue vision in the chimpanzee.

Under essentially similar conditions of experimentation, but with the substitution of yellow for blue, in a yellow-red series (p. 80), the existence of color vision was still further tested, with positive results.

The work of Köhler is subject to various adverse criticisms because of the relatively limited control of stimuli and the lack of physical measurements thereof. Nevertheless, it is clear that his observations definitely indicate, even if they do not absolutely prove, the existence of blue-yellow-red vision in the chimpanzee. Fortunately we are helped still further toward definite and critical decision regarding the conclusiveness of these experiments by the comparable observations of Kohts which we shall now report.

Kohts has investigated with thoroughness the characteristics of vision in the chimpanzee. Her publications are valuable also because of her discussions of method and of the attitude and modes of response exhibited by her subject in varying observational situations. Apart from a German summary of her chief publication (1923) and a *résumé* published in French (1928), her reports, as thus far published, are in Russian (Kohts, 1921, 1923), but a critical review and digest of the studies of chimpanzee vision has been published in English (Yerkes and Petrunkevitch, 1925). Since we doubt our ability to improve on the reviewers' description of the methods and results of this investigation with respect either to clarity or brevity, we quote as follows and somewhat at length. It is pertinent to remark that the few paragraphs quoted represent the content of more than three hundred pages of the author's text.

It should be noted at the outset that this work was carried on under relatively unfavorable conditions since Russia was cut off from natural sources of scientific aid. In her preface the author states that she was compelled to limit her work to a single chimpanzee, and it was impossible to obtain a series of color samples of standardized intensity and the Bradley series of neutral stimuli. She indicates her intention of continuing her work until she has made "an exact psychological analysis of the facts which the experiments have brought out and expressed them in psychological terms."

Initially Mrs. Kohts undertook to study visual discrimination in Ioni through the establishment of auditory-visual-motor associations and the development of a visual-motor response to an auditory stimulus as a conditioned reflex. The experiment involved the presentation of achromatic stimuli in the form of white and black surfaces and naming by the experimenter of the particular stimulus or object to be selected and handed over by the animal. This procedure used through five hundred experiments yielded negative results in that the auditory impression (name of object to be selected) was not associated with the visual impression. It was demonstrated nevertheless that

Fig. 102. Mrs. Kohts experimenting with the chimpanzee "Ioni." From N. Kohts, 1923.

the animal could distinguish readily black from white. Although this particular method and its results demand small space for description, they are extraordinarily significant in that they indicate extreme difference in the values of auditory and visual stimuli for the chimpanzee.

An important by-product of this initial method of experimentation was the discovery that the temperament as well as the intellectual equipment of the animal must be taken into account in planning and executing experiments. Ioni objected strenuously to sitting quietly before the experiment table. When forced by the investigator to face the experimental situation he screamed loudly with wide-open jaws and arms raised and outstretched. His sole desire seemed to be for freedom and play. The observer early decided that opportunity for play could be effectively used as incentive and reward for work in the experiment. She therefore used as reward throughout her investigation, opportunity to play games of which the young chimpanzee is especially fond, involving chasing, catching, and wrestling. Punishment was not used, save as prolonged sitting at the experimental table was disagreeable to the ape. Indeed, after he had made several incorrect choices the utterance of the word "wrong" by the experimenter would induce an expression of sadness sometimes accompanied by protrusion of the lips and crying. Success in the experiment resulted speedily in freedom for play activity whereas failure came to mean continuation of unpleasant effort.

Another important result of the method of naming was the discovery that Ioni reacted correctly when from a group of stimuli he was repeatedly asked to select the same object. This circumstance, Mrs. Kohts says, induced her to try the following method in studying visual discrimination.

The chimpanzee was placed before a table on which two or more objects were offered for discrimination and choice. On the opposite side of the table sat the experimenter. The animal was required to make its choice by selecting an object identical in one or more respects with a sample shown by the experimenter.

This method of "choice from sample," although not entirely new in comparative psychology, has never been used systematically, extensively, and with the degree of critical elaboration which Mrs. Kohts' work exhibits.

The method involves (1) presentation of sample object as symbol of experimenter's command to select from the objects on the table one like it, (2) search by animal for desired object, and (3) recognition of right object (or failure to discover it) and handing of same to the experimenter.

The experimental situation which was created and utilized under the title "choice from sample" offers peculiar risks of error. This the observer

fully realized and endeavored to remedy. All experienced investigators will suspect that the chimpanzee's choices were inevitably influenced, consciously or unconsciously, by the observer. Mrs. Kohts in asserting that this was not the case presents the following types of evidence: (1) Independent use by Ioni of the ability discovered to him by the experiment—the spontaneous and independent use of his knowledge beyond the experimental situation; (2) successful reactions with different experimenters despite change in locality, time of work, and surroundings; (3) successful reaction when the object to be selected was hidden in a large group of similar objects; (4) confusion of animal and sometimes refusal to work when conditions of discrimination were changed, as for example, in selection in accordance with number instead of color. This, it is stated, occurred despite prolonged experimentation and "the lively wish of the experimenter for success"; (5) marked improvement as a result of previous practice with similar problems; (6) change in rapidity and ease of solution corresponding to change in complexity of problem; (7) presentation by the animal of unforeseen and, by the experimenter unexpected, independent thoughtful solutions of problems; (8) choice of identical object on the basis of kinaesthetic instead of visual stimuli—objects to be selected from being concealed in a bag tightly closed around the arm of the chimpanzee.

Whether or not the investigator succeeded ideally in guarding against the direct influence of the experimenter, it is entirely clear that she was aware of the risk and ingeniously controlled and checked her observations. There can be no doubt that the results are highly valuable qualitatively considered and that other values are even more seriously affected by the nature of the specific stimuli than by the proximity of the observer.

In commenting further on the characteristics of this relatively new method of studying visual discrimination, the author particularly invites attention to the plasticity of the method—the possibility of endless variation in form and content of problem, the avoidance of repetition in successive experiments and consequent escape from the automatic and stereotyped in experimental setting and in response. The stimuli can be varied readily in place of presentation, relative position, form, time of exposure, number, arrangement, and so on. Similarly the object to be selected may be placed in varying relations to surrounding objects. The relation between the animal and the experimenter likewise is plastic and is comparable, Mrs. Kohts thinks, to a kind of conventional speech. "This relation gave in these experiments a natural and direct means of discovering in a short time and without difficulty the highly varied elementary intellectual abilities of the chimpanzee and the limits of their possible development."

In a surprisingly short time, the author goes on to say, there were carried out by this method experiments on the discrimination of achromatic and chromatic stimuli, recognition of manifold planimetric and stereometric figures, discrimination of different volumes and surfaces—length, breadth, and height, recognition of combinations of colors, letters and pictures. Furthermore, certain modification of the method threw definite light on elementary abstraction, and changes in the performance of the animal consequent on modification of experimental conditions supplied a valuable criterion for the evaluation of factors which either favored or hindered the solution of a given problem. Thus the method tended to reveal the psychological nature of the chimpanzee's behavior.

It proved no easy task to accustom and train Ioni to the method of choice from sample. The task was tedious and it evidently required patience, resourcefulness, and ingenuity on the part of the observer. But once he had succeeded in adapting himself to the requirements of the experimental situation work proceeded with gratifying rapidity and success. Mrs. Kohts describes at great length her experimental procedure, phases of the animal's relation to the procedure, and the methodological steps which eventually led her to valuable information concerning visual discrimination, abstraction, and emotional behavior.

The method of experimentation having been perfected and the animal thoroughly accustomed to it, ability to discriminate the primary colors and the degree and extent of ability to discriminate similar hues were in turn investigated. In all of these visual experiments stimulus was supplied by a pigmented reflecting surface. The conditions are therefore incapable of exact physical description and the reader for approximate knowledge of the colored papers used must be referred to the color charts of the report.

In summing up the results of her extended study of visual discrimination, the author states that her analysis of behavior indicates that in his selection of chromatic stimuli Ioni depends upon hue and not upon brightness. Chromatic stimuli which are closely similar in hue but differ considerably in chroma or saturation are more easily distinguished by the chimpanzee than are stimuli which differ sharply in brightness or intensity but are closely similar in chroma. Mrs. Kohts believes that she has demonstrated that hue is more important than brightness in the natural color discrimination and selection of the chimpanzee. She thus briefly summarizes her principal conclusions: (1) The chimpanzee is able to distinguish and discriminate colors of both halves of the spectrum; (2) correct discrimination occurs in the simultaneous presentation of colors in groups of two to twenty; (3) the degree of accuracy in the discrimination of forty chromatic stimuli tested depends upon the relative nearness in hue of the simultaneously presented stimuli; (4) the relative

brightness of the chromatic stimuli does not influence the discrimination; (5) achromatic stimuli with the exception of white and black are not as well distinguished by the chimpanzee as are chromatic stimuli. (Yerkes and Petrunkevitch, 1925, pp. 101-105.)

Although the experiments of Kohts are subject to the same fundamental adverse criticisms as those of Köhler, namely, that the chromatic stimuli were neither perfectly controllable nor described in terms of physical measurement, in a type of experimental situation very different from that used by Köhler, Kohts employed a much greater number and variety of chromatic stimuli and, it would seem, took more varied precautions to control her experiments and to avoid erroneous conclusions. Nevertheless, her results are substantially in accord with those of Köhler, and it consequently seems entirely justifiable to state that the chimpanzee, as indicated by careful study of visual response in five individuals, possesses color vision similar to, if not actually identical with, the human. Whereas Köhler made no measurements of limits or range of sensitiveness, acuity, and fineness of discrimination in the color reactions of the chimpanzee, the experiments of Kohts contribute importantly to our knowledge of these aspects of vision. Hence it would appear that her work, and particularly that on color vision, is first in importance because of reliability and extent of the information supplied.

Finally, it should be remarked that the reader who by the Russian text is discouraged from examination of Kohts's volume, will nevertheless be able to learn much from careful study of its numerous illustrations of the chimpanzee at work, of apparatus and the experimental situation, from plates which reproduce the color stimuli and combinations of colors utilized in the investigation, and from the excellent summaries in French and German.

For the first time in our present task of exposition, examination of methods and results in the study of some particular aspect of the reactive capacity of the chimpanzee has enabled us to run the gamut from entirely uncontrolled, casual, and impressionistic observations and descriptions of behavior to thoroughgoing, systematic investigation under controlled conditions and with critically scrutinized and rigorously checked results and conclusions. Whereas heretofore our tentative conclusions have usually rested upon more or less obviously unsatisfactory data, in case of chimpanzee color vision we have the rare good fortune of an assemblage of carefully observed responses.

NONCHROMATIC VISION

In man, two series or systems of visual sensation are known: color sensations and light sensations, or chromatic and nonchromatic. The first includes all sensations of color, and the second, sensations of white, gray, and black. A totally color-blind person experiences only sensations of light (nonchromatic). But the reverse condition, light blindness, associated with color vision, has never been discovered. Hence we ordinarily infer the existence of both systems of sensation when the presence of color vision has been demonstrated.

Many observers have noted the responsiveness of the chimpanzee to nonchromatic stimuli, and it may be stated with assurance that the animal possesses fairly well-developed light vision and is capable of responding appropriately to what we designate as sensations of white, gray, and black. However, to the systematic, intensive, and extensive investigations of Köhler (1915, 1918) and Kohts (1921, 1923, 1928) we owe almost all definite information concerning the characteristics of chimpanzee vision. These authors have demonstrated ability to discriminate nonchromatic stimuli and have roughly compared the importance of such with the contrasted ability to respond to chromatic stimuli. As we have previously stated, Kohts concludes that achromatic stimuli, with the exception of the extremes white and black, are not so readily distinguished by the chimpanzee as are chromatic. Neither of these investiga-

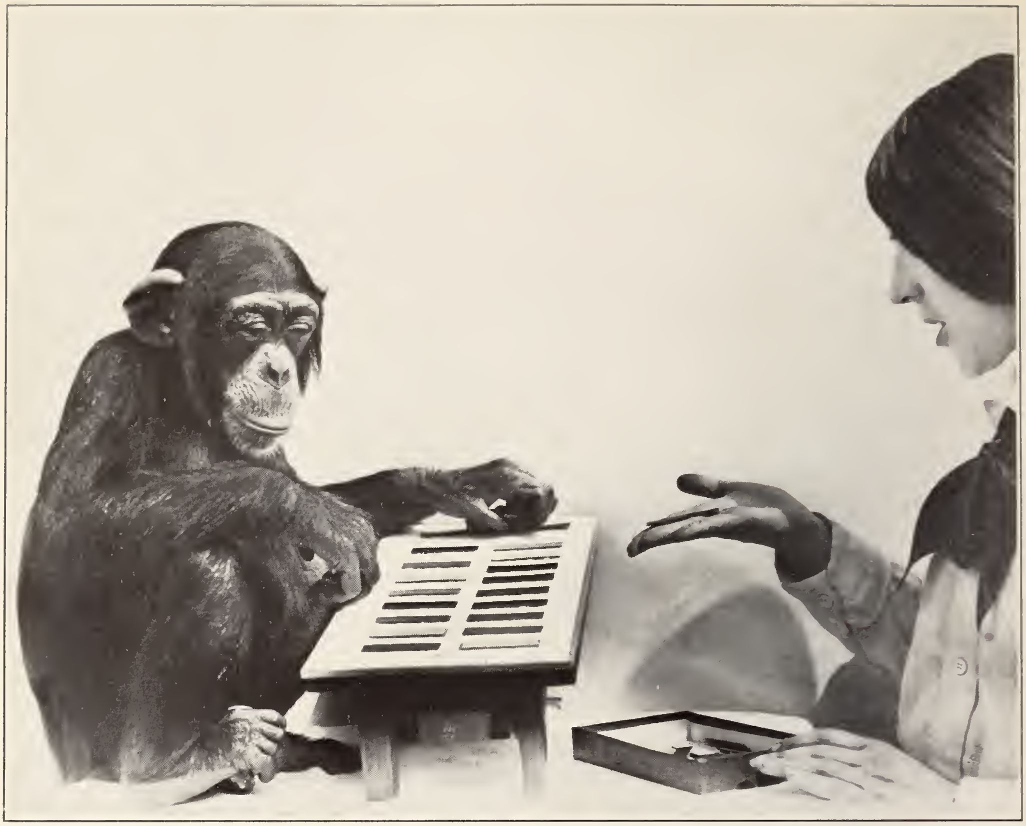


Fig. 103. "Ioni" matching sample object in the experimenter's hand. From N. Kohts, 1923.

tors has made measurements of the range and acuity of sensitiveness to light which would render comparison with corresponding human data possible.

By way of general summary it may be stated, on the basis of reliable observations, that the chimpanzee possesses two sorts of visual sensitiveness, the nonchromatic and the chromatic, and further that both light and color vision are well developed by comparison with conditions existing in other infrahuman animals. Certain additional important facts concerning visual function we shall present under the topic perception.

For modes of sense other than vision, available information is extremely meager and obviously unreliable. No careful naturalistic or experimental studies have been reported, and where we might hope for completeness of description, accuracy, and precision, we discover only vague impressionistic fragments of description. But in order to present consensus of opinion, even where facts are few, and to refer to such informational sources as we have discovered, we shall now devote a few paragraphs to each of the principal sense modes which is attributed to the chimpanzee: hearing, touch, temperature, smell, taste, and pain.

HEARING

No one who has carefully observed chimpanzees in freedom or in captivity can doubt the keenness and biological importance of hearing. But answers are not available to such interesting questions as: Does this sense rank next in importance to vision? Or, are the chemical senses smell and taste more highly developed? How do the characteristics of chimpanzee hearing com-

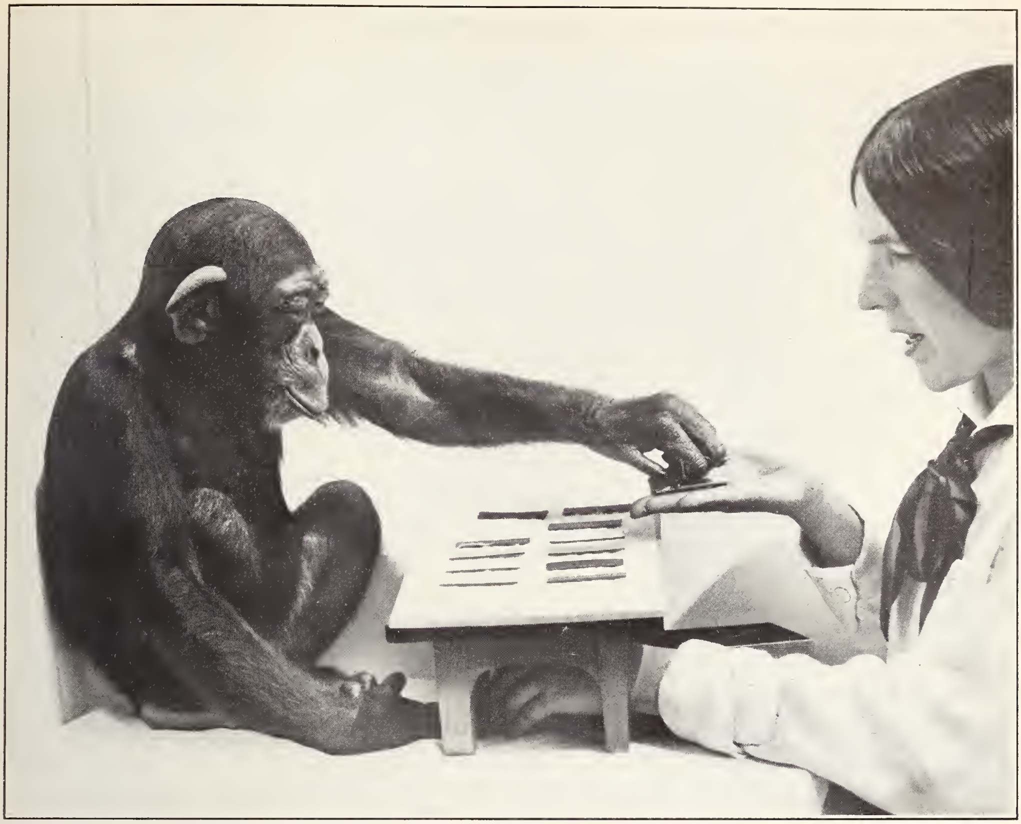


Fig. 104. Completion of response whose beginning is recorded in fig. 103.

pare with our own? When we consider the amount of attention that has been given to chimpanzees through the centuries, it seems almost incredible that we should be unable to answer such questions, should, in fact, know almost nothing concerning so obvious and also so essential a sense as hearing.

Structural information, as usual, we note only in passing. There is a paucity of this also. Yet in Traill (1821), Schwalbe (1891, 1915), and Sonntag (1923, 1924) are found certain contributions to morphological description of the ear, and in the latter especially a digest of the literature and a useful bibliography. We therefore refer the reader more particularly to Sonntag (1923, pp. 416-417, and 1924, pp. 315-317).

As we frequently have had occasion to state in other connections, so here, there is a superabundance of general and seemingly unsubstantiated inferential statements concerning hearing. A single example will suffice to illustrate the point. We have selected Warwick as exhibit. This author from brief observation (quoted by us on page 169) of the behavior of a chimpanzee and an orang-outan in captivity concluded that in both hearing was remarkably acute.

Not all naturalists are as free with inferential descriptions as is Warwick. For the sake of contrast we would cite the recent descriptions of Kearton, who wisely, as we believe, refrains from attempting to specify the sense mode or modes which may have functioned in certain situations. Thus, for example, in his account of the detection by Toto of the near presence of a lion, the observer refrains from inferential analysis or, in other words, from telling what he did not know. In this particular instance prob-

ably several sense modes were involved: vision, hearing, smell possibly, and perhaps yet others.

Experiments on chimpanzee audition are conspicuous by their absence. We have found no noteworthy contributions of fact in the writings of Köhler, Kohts, or any other of the chief contributors to the literature, and we conclude that this animal's hearing is virtually a *terra incognita* to the psychobiologist.

TOUCH AND TEMPERATURE

These modes of sense are only casually mentioned. There is no single contribution which may be characterized as scientific. Sensitiveness to touch, contact, pressure, and also to cold and warmth, is observable. Yet, strange to say, there appears to be no systematic account of the receptors, range, acuity, or characteristic forms of response for these undoubtedly existing modes of sense.

Certain pertinent morphological statements which indicate among other things that organs of touch probably exist in the skin of the hands and feet are presented by Schlaginhaufen (1905, pp. 663-665) and Sonntag (1923, pp. 417-418).

Report is made by Kohts (1921) on the ability of her subject Ioni to identify, by touch, objects which were hidden from view in a bag. From our own observations we should affirm the existence of well-developed touch and temperature sensitiveness, but should infer from the behavior of the animal and also the structural condition of the skin, that these senses probably are less keen in chimpanzee than in man.

SMELL AND TASTE

"The organs of taste differ little from the human. The tongue is large and fleshy, as in man, and its surface is covered with numerous papillæ." Thus wrote Traill more than a century ago (1821, pp. 38-39). This morphological beginning seems not to have stimulated progress, for we have failed to discover in our informational sources, summary descriptions of chemical receptors or indeed references to pertinent literature.

General observation establishes the existence of smell and taste in the chimpanzee and suggests that each sense mode is of very considerable practical importance in the daily life of the animal. The statement is frequently made that objects are examined, tested, and their food value determined by the use of smell, taste, touch, and vision. Whether either or both of the chemical senses is more important in this connection than vision is not known.

From their observations in the Canary Island Anthropoid Station, Rothmann and Teuber (1915, p. 11) assert that smell is more important for the chimpanzee than for man, and that taste also is undoubtedly well developed. Of a mature female specimen of the Tschego it is said that she sweated profusely and that the secretion had a typically negro odor. Although this observation may have no sensory significance, the resemblance between the body odor of the chimpanzee and that of the Negro suggests possibly fruitful lines of genetic inquiry.

Although Köhler's experimental investigations of the senses were concentrated on vision, he had occasion to note the functioning of other senses and in his reports has offered certain information concerning them. Thus, for example, of the sense of smell, he says that on the basis of anatomical conditions as well as on his observations of behavior, it is to be inferred that this sense mode is even less well developed than in man. The chimpanzee, he states, when at least sixty centimeters distant from the object, is unable to perceive and localize the odor of a bit of apple, orange, or grape. We do not understand from this investigator's description that the animal is necessarily incapable of smelling the fruit, but instead that it is unable to localize it as coming from the one or the other of two adjacent boxes sixty centimeters away (Köhler, 1915, p. 28). That we have correctly interpreted Köhler as believing that the sense of smell is very poorly developed in the

chimpanzee is further indicated by his remarks concerning the possible use of this sense in locating buried food.

> That the outcome of these tests with chimpanzees cannot be attributed to the sense of smell needs no further elaboration. Anthropoids have this sense to a very limited degree; a hidden pear, tomato, or the like (the kind of fruit we used), is not smelt a couple of decimetres away. And yet in the last test the animals ran immediately and straight to practically the correct spot. (Köhler, 1925, p. 292, footnote.)

So positive was this observer that smell is poorly developed in the chimpanzee that in his buried-food experiment he took no precautions whatever to eliminate odor as a directive influence.

While we should agree with Köhler, on the basis of our own observational data, that the acuity of smell is low, we suspect that he underestimates both degree of development and importance in the life of the organism, and we are inclined to believe, and tentatively state, that in all probability both smell and taste in the chimpanzee are comparable in keenness and usefulness with like modes of sense in man.

PAIN

Only a few vague and valueless references to indications of pain or physical discomfort appear in the literature and we do not know of a single significant statement concerning pain as mode of sense. Concerning the behavior of a chimpanzee which sometimes fell heavily to the ground when performing acrobatic tricks, Köhler remarks:

> The draw-back is obviously the violent impact of a headlong fall from five metres onto hard piece of ground. Chica often inspects and touches those portions of her body which have borne the brunt of the fall, and walks away with slow and subdued gait; but, thanks to her incomparable skill as a tumbler, she received no serious injuries. (Köhler, 1925, pp. 73-74.)

Evidences of discomfort, acute suffering, and even agony in serious illnesses, surgical operations, and accidental injuries, have frequently been reported and we have several times ourselves observed such expressive behavior. Our data on pain due to stimulation of the surface of the body, gained chiefly from watching the behavior of subjects which were either self-mutilated or had injured one another, suggest that the acuity of the cutaneous pain sense is very considerably less than in man.

This chapter has been made particularly explicit for the purpose of emphasizing opportunity for fruitful research (for list of problems see Yerkes, 1927b). With the exception of vision, almost nothing is definitely known concerning the modes of sense and the types and characteristics of sensory responses in the chimpanzee. For the psychobiologist who is interested in problems of receptivity and considers knowledge of this aspect of an organism's life supremely important for our understanding of behavior, the chimpanzee is a collection of interrogation points. That it may be worked with readily and also profitably is abundantly proved by the studies of visual sensitiveness and visual perception conducted by Köhler and Kohts.

CHAPTER TWENTY-SIX

PERCEPTUAL PROCESSES OF CHIMPANZEE

NUMEROUS reports on the behavior of free and captive chimpanzees establish the existence in them of varied and excellent observational, or perceptual, ability. Provided with several well-developed modes of sense, this ape uses its receptors promptly, skilfully, persistently, in searching for, locating, testing, examining, and investigating objects of its environment and in thus acquainting itself with their properties and relations. Generally speaking, it is observationally alert, keen, aggressive, ingenious, and sagacious. From an unusually imposing list of contributors to our reasonably adequate general information on this topic, we would quote illustratively from one only, Rennie. We have selected this author because, in addition to being pertinent, his paragraph supplements our previous account of language and prepares the way for our consideration of intelligence.

In natural shrewdness and sagacity, however, Tommy greatly excelled the human infant, and, indeed for that matter, many grown individuals. The cerebral development of the chimpanzee's skull has been compared with that of the human idiot; but whatever similarity may exist in the crania, there is certainly no resemblance whatever between the respective intellects; and this is a strong proof of the caution which should be observed, and the little value to be placed, upon those analogical reasonings which pretend to deduce mental phenomena from material developments. But it is more particularly in interpreting your wishes and intentions from your looks, tones, and gestures, that this animal exhibited the most wonderful quickness of apprehension, vastly superior, indeed, to that of ordinary man, and only equalled by what we observe in deaf and dumb people, whose defect of speech is compensated by this unusual acuteness of observation. We have seen Tommy on one occasion, when commanded by his keeper to bring him the core of an apple which he had thrown down on the floor of his cage, manifest the greatest anxiety to obey, though much perplexed to discover what it was he was required to do, as he evidently did not comprehend the nature of the order. He moved towards the window, stopped and looked back at the keeper, and then at the company; perceiving by their looks that he was mistaken, he returned, put his hand upon his swing as if to mount, again looked round to see if he was right, and was manifestly much puzzled what to do; at length one of the spectators pointed to the core of the apple, he stretched his hand towards it, looked inquiringly at the keeper, hesitated for a moment till he received the expected nod of approbation, and then lifted and carried it to his attendant without farther hesitation. (Rennie, 1838, pp. 70-71.)

The senses provide items of experience called sensations, which by suitable combination, alone or in conjunction with memory images, constitute perceptual configurations. These statements we base on human experience. Without positive evidences we may not reasonably assume the existence of sensory, imaginal, or perceptual processes in the chimpanzee. It is with such evidences, behavioral or structural, that we are concerned in this and the following chapters of this part of our volume. Our conclusion from the facts already presented is that the existence of several modes and systems of sensation may reasonably be inferred. We shall now present observations which we believe similarly justify assumption or inference of the existence of perceptual processes and configurations in the mind of this ape.

Demonstration of modes of receptivity and sensation is only the first step in the analysis of consciousness in chimpanzee or man. Following insistently on the question, "Does the animal experience sensations of light and color, and does it so act?" are the more difficultly answered inquiries, "How, if at all, does it see or perceive light and color, size and shape, depth and number, objects or configurations, and what are the outstanding features of a single object or succession of events?" To the consideration

of attempts to answer such questions, the how and what of perception, we now turn.

Even hasty examination of the literature suggests that the evidences naturally fall into three categories: first, that of miscellaneous and incidental observations typified by the quotation from Rennie; second, pioneer tests or experiments under partially controlled conditions, and third, more intensive, critical, and sustained experimental investigations. The first of these categories we already have briefly characterized. Results typical of the second and third we would now present as briefly as is consistent with clarity.

As a pioneer in this field, Romanes, with a female specimen of the "bald chimpanzee" (*Anthropopithecus calvus*), made, or rather directed, certain simple experiments on perception of color and number. As previously stated (p. 314), his results for color were negative and he was, as we now believe erroneously, led to pronounce his subject color blind. His tests on perception of number, or counting, on the contrary, yielded positive results. With apology for repetition (see p. 307) we review the method of experimentation.

The investigator requested and directed keepers of the animal repeatedly to ask it to hand them one, two, or three straws. When the chimpanzee responded correctly she was rewarded with a piece of fruit. Thus, finally, three names or verbal commands were coupled with their appropriate objects. It was required that the total number of straws be handed to the keeper simultaneously instead of one by one.

Of this procedure and its indications Romanes remarks:

> As soon as the animal understood what was required, and had learnt to associate these three numbers with their names, she never failed to give the number of straws asked for. Her education was then extended in a similar manner from three to four, and from four to five straws. Here, for reasons to be presently stated, I allowed her education to terminate. But more recently one of the keepers has endeavoured to advance her instruction as far as ten. The result, however, is what might have been anticipated. Although she very rarely makes any mistake in handing out one, two, three, four, or five straws, according to the number asked for, and although she is usually accurate in handing out as many as six or seven, when the numbers eight, nine, or ten are named, the result becomes more and more uncertain, so as to be suggestive of guesswork. It is evident, however, that she understands the words seven, eight, nine, and ten to betoken numbers higher than those below them; and if she is asked for any of these numbers (*i.e.*, above six), she always gives some number that is above six and not more than ten; but there is no such constant accuracy displayed in handing out the exact number named as is the case below six. On the whole, then, while there is no doubt that this animal can accurately compute any number of straws up to five, beyond five the accuracy of her computation becomes progressively diminished.
>
> It is to be noticed that the ape exhibits some idea of multiplication; for she very frequently (especially when dealing with numbers above five) doubles over a long straw so as to make it present two ends, and thus to appear as two straws. Any of the comparatively rare errors which she now makes in dealing with numbers below six are almost invariably due to her thus endeavouring to duplicate her straws. In this connexion it is to be remembered that, owing to the method above described (whereby the ape is required to place each straw separately in her mouth until the sum asked for is completed), when any high number is demanded, a considerable tax is imposed upon her patience; and as her movements are deliberate while her store of patience is but small, it is evident to all observers that the doubling of the straws is intended to save trouble by getting the sum completed with greater rapidity than is possible when every straw is picked up separately. Of course we do not recognize these doubled straws as equivalent to two straws, and therefore the persistency with which she endeavours to palm them off as such is the more noteworthy as evidence of her idea of multiplication. Moreover, I am disposed to think that the uncertainty which attends her dealing with the numbers six and seven is more largely due to her losing patience than to her losing count; although after seven I believe that her computation of the numbers themselves becomes vague, or merged in a merely general idea of many. It may also be stated that while picking up the straws and placing them in her mouth she looks only at the straws themselves, and not at the person who asks for them: therefore she is certainly not actuated in her responses by interpreting facial expression, unconscious gesture, &c., as is no doubt the case with many dogs which, on this account, are sometimes accredited by their owners with powers of "thought reading." It is needless to add that, after asking for the number of straws required, we remain silent till the ape has handed them out. (Romanes, 1889a, pp. 318-319.)

For reasons which perhaps are both illogical and inadequate, Romanes infers that the chimpanzee may not reasonably be expected to perceive numbers greater than five.

Perception of number as studied by Marbe may more fittingly be described after we have completed our survey of semi-scientific contributions.

Garner (1905, pp. 275-278) describes experiments with a "Kulu-Kamba," estimated to be one to two years old. The animal was first trained to manipulate a wooden block two by two inches, in order to obtain a bit of food as reward. After it had mastered this requirement, it was presented simultaneously with a board six by twelve inches in which a two by two inch hole had been cut, and was taught to fit the small block into the hole in order to obtain a peanut. As soon as this lesson had been mastered, a circular block two and one-quarter inches in diameter was added to the equipment, and the subject was taught that when she manipulated this new block in a certain way a bit of pineapple would appear. Of the animal's behavior in connection with this experimental situation, the author writes:

> She at once laid aside the squares and devoted herself to the round block, which, for a time, produced the morsel of fruit without the aid of a board. At length, however, the block alone ceased to yield its quota of fruit, and another board, having a round hole in it, was introduced. Without having to be shown, she promptly adjusted the block to its place, turned up the board and found the bit of pineapple. For about half an hour her attention was centered upon the new board and block. Suddenly she paused in her work and began looking about her as though trying to recall something to mind. Then she turned to the squares again and quickly found a peanut. After a few had been thus produced, I exchanged the square figures for the circles. She turned them only once, and, finding the pineapple instead of the peanut, she at once turned again to the squares and insisted upon having them.
>
> Within a day or two she was as decided in choosing the block and board, preferred for the time being, as any human being could have been. . . . The fact that she clearly distinguished the two geometrical figures was quite certain.
>
> [Next] I substituted a single board, having the two holes cut into it, for the two separate boards formerly used. The two blocks were placed within her reach and she was allowed to proceed without any suggestion to aid her. She selected the square block and fitted it into the board. The usual result of finding a peanut instantly followed, and she was permitted to do this as often and as rapidly as she chose. About half a pint of nuts was required for the occasion. A brief pause ensued and she exchanged blocks. She made no mistake in placing either of them.
>
> The next day, I placed four round blocks and one square one in a pile near her. She instantly pushed the round blocks aside and took up the square one, which she at once put into use. When she had obtained enough peanuts to satisfy her, she again turned to the round ones and picked out the particular block which she had before been using. It was not difficult for me to distinguish this block from the others, partly by the grain of the wood and partly from its being slightly soiled from handling, but that she should observe these very faint marks of identity was quite unexpected.
>
> That afternoon the three superfluous round blocks were removed and a triangular one placed in their stead. The three figures were stacked up, with the square at the bottom, the triangle on top and the circle between them. The new figure at once caught her attention, but certainly did not deceive her. She picked it up, examined it for a moment, placed it in front of her and then turned it up, as if to ascertain what manner of food it might produce, but she made no attempt to fit it into the board; and after one trial abandoned it and took up the square. (Garner, 1905, pp. 276-277.)

Finally, the experimental equipment consisted of square, circular, triangular, and lozenge-shaped blocks, and boards with appropriate holes. "The lozenge block was then mixed with the others, and, while she seemed to be aware that it was a new form, she often confounded it with the square and occasionally with the triangle, but not once with the circle." (1905, p. 278.) Up to the time of discontinuance of the investigation, because the subject "had run away," ability quickly to perceive the correspondence between block and hole for these several geometrical figures had not been perfectly demonstrated.

Except as pioneering, the perceptual experiments of Garner would deserve only passing notice, for his methods were crude and his procedure as well as his results are inadequately described and his results unchecked by such control tests as might be

expected to reveal dependence upon other aspects of the situation than form.

Frequently appearing in seemingly reliable accounts of chimpanzee life are observations essentially like the following from the reports of Furness (1916, pp. 285 ff.). This author presents, among other evidences of perceptual keenness, observation and discrimination of keys, persons, and knots.

The right key for each of several locks may be recognized and selected for use from among several others, even though the objects be as much alike as the keys of two Yale locks. This statement, of course, implies acquired interest in the key as an instrument and desire to use it as such.

Mimi, a Furness subject, taken one day for demonstration before a group of approximately one hundred and twenty-five people, noticed four or five individuals enter by a side door and among them promptly perceived, recognized, and greeted a former acquaintance. Such instances of ability to discriminate among people and to recognize friends after a long interval of separation have many times been reported.

The tying of knots by his subjects Furness describes as impossible, because, presumably, of inadequacy of perception or of motor coördination. Drawing likewise proved impossible. Many interesting unsolved problems of perception are suggested by these failures.

Taking his suggestion probably from the work of Garner or from the current method of testing young children, Furness, as described below in his own words, made certain experiments on perception of form in the chimpanzee, the results of which agree closely with those of Garner.

> To test her ability to compare shape and size I have used an ordinary form-board consisting of ten differently shaped blocks about half an inch thick and a board wherein are cut ten hollows corresponding in size and shape to the blocks. The hollows are about ⅜ inch deep and to make them more easily seen are painted black inside. The trial consists of placing quickly all the blocks in their corresponding hollows. The actual time required by an adult human being is about twenty seconds. It is strange that with so quick a memory for the shapes of the letters and the keys she should find so much difficulty in mastering the form-board. After hundreds of trials she is never certain to get all ten blocks in place without considerable hesitation and one or two misfits. The more elaborate they are in shape the easier it appears to be for her to place them; the five point star is almost always her first selection from the pile and seldom does she hesitate over it; the equilateral cross is likewise readily placed, but the simple square, the oblong and the lozenge are invariably shifted from one hole to another all over the board. The shortest time in which she has placed them all correctly, so far, is 35 seconds. (Furness, 1916, pp. 286-287.)

Although among pioneer tests of perception we might describe several others, such use of our space seems undesirable inasmuch as the investigations of Marbe, Köhler, and Kohts, now to be reported, rob previous studies in perception of everything except historical interest and value.

Perceptual aspects of the behavior of an adult female chimpanzee named Basso have been studied by Marbe (1916-17) in the Zoölogical Garden at Frankfurt, Germany. This captive, mentioned by Knauer (1915, pp. 88 ff.) and Heck (1922, p. 673), had been taught by her keeper to entertain visitors by answering questions in arithmetic. We quote:

> When Basso's keeper wishes to demonstrate her skill in arithmetic, he sits at a small table on which are lying ten small wooden blocks which are painted black on one side and bear the numbers one to ten in white. The blocks are placed irregularly but so that the numerals are visible without turning them. To the keeper's left sits Basso. All the questions which Basso is to answer are given in such way that she can respond by lifting the appropriate block which the keeper receives and lays on the table. In some problems she has to take up only one block, but in many real addition is required—for example, to designate eleven she picks up first the figure ten and then one. (Marbe, 1916-17, pp. 140-141.)

The investigator reports that when answering arithmetical questions the chimpanzee always watched her keeper. Often she seemed undecided. Occasionally it seemed that she took up the correct block without looking at it. Difficult as well as easy arithmetical questions were correctly answered.

Examples of such are: "When you add two to twenty-eight what is the sixth part of it; the tenth part, the third part?"

Marbe fully describes the keeper's tuitional method. Bottles were first used to establish association of number terms with objects and groups of objects. Subsequently the number terms were associated with the symbols which appeared on the wooden blocks. Thus finally a system of associations was established which enabled the animal to respond appropriately to any arithmetical question which was presented.

To the critical investigator Basso's behavior suggested the possibility of automatic or real counting, thought reading, perception of signs unconsciously given by the keeper, or deliberate deception by the keeper. Investigation eliminated as possibilities automatic and real counting and also mind reading. It demonstrated the dependence of the chimpanzee on signs, either consciously or unconsciously given by the keeper.

> All these experiments seemed to show that Basso reacts not only in the sense of the median plane theory [inclination of keeper's body toward correct block], but that she can and does make use of other signs unconsciously given by the keeper. Our experiments also show that chimpanzees have excellent power of observation for human signs, and they permit one to suppose that these apes not only know how to react to signs given by men but also to those given by other animals and especially by other chimpanzees, more so than has hitherto been assumed. (*Ibid.*, p. 169.)

Marbe's inquiry concerning the seemingly remarkable ability of Basso demonstrated the possession of keen vision, excellent powers of observation, and the possibility of speedy acquisition of numerous and varied associations. It contraindicated understanding of the arithmetical questions asked, true counting and reckoning.

Whereas all previous observers had concerned themselves especially with the demonstration of the existence of one or another type of perceptual process, as, for example, color, form, size, Köhler attempted to find out something about the how and the what of perception. His contribution has elsewhere been thus favorably and we believe justly characterized:

> In the realm of visual perception the contributions of Köhler are epoch-making and undoubtedly will have a profound influence on the development of comparative psychology. Working with extremely meager instrumental equipment and resources, he displayed ingenuity and skill which should stimulate and inspire those who labor in poorly equipped laboratories. (Yerkes and Child, 1927, p. 47.)

Problems of visual perception, investigated by Köhler, are typified by those now to be described. Since this author's contribution is extensive, it is impossible completely to summarize it in a few pages. As will appear, his problems ordinarily were suggested by human experience, and his methods were so devised as to render possible direct comparison of the perceptual processes of the chimpanzee with those of man. In this account of his work we shall for each line of inquiry state the problem in the form of a question, briefly describe the method of experimentation, and summarily state the results of observation.

In adjusting to spatial relations, the eyes of the chimpanzee apparently act essentially as do those of man. There is, for example, convergence, fixation, and variation in pupil opening. Does the animal perceive objects differently with two eyes than with one? Does it perceive depth or distance more readily and accurately binocularly, as does man, than with either eye alone? (See Köhler, 1915.)

For the solution of this problem two methods were employed, in each of which the subject responded now to binocular and again to monocular vision. For the first series of observations a banana was placed as reward of success at varying distances behind a wire screen, before which the subject stood or sat. When ready to make an observation the experimenter handed to the animal two hollow sticks, which were so related that the one might be fitted into the other. Neither stick was long enough to enable the animal to reach the food beyond the screen, but united they constituted an effective instrument. The subject, previ-

ously practiced in fitting the sticks together, was required to perform this act, guided either by binocular vision or by monocular vision. In each instance the time required for success was recorded as a measure of the efficiency of depth or distance perception. For the only subject used, Sultan, a right-handed animal, the following results were obtained. Time for binocular vision, 2.1 seconds; for monocular vision with right eye, 3.4 seconds, and for monocular vision with left eye, 5 seconds (*ibid.*, p. 9).

By what is known as the Hering fall-experiment, additional observations were made on conditions of depth perception. In this case the subject stood before a barrier in which a small hole at the level of the eye permitted it to see a grape which was suspended by an invisible thread. At the appropriate instant the experimenter dislodged the grape and it fell to the floor of the chamber. It was required that the observing subject visually locate the object as falling either before or behind a screen which divided the chamber into two parts. Having observed the disappearance of the grape, the chimpanzee, according to the nature of its perceptual data, went to either the nearer or the farther of the two compartments in order to obtain its reward. Briefly put, the experiment demonstrated that the desired object could be correctly located, with binocular vision, in 84 per cent of the trials, and with monocular vision in 53.3 per cent. For a right-handed subject, vision with the right eye alone yielded 58.3 per cent correct choices, and with the left eye alone 48.7 per cent (*ibid.*, p. 16).

It further is indicated that in the chimpanzee, as in man, depth, distance, and direction of movement are more readily detected and more accurately perceived binocularly than monocularly.

Does visual perception of size depend on the area of the retinal image, or can the chimpanzee, as does man, recognize one object as larger than another, even although by reason of greater distance from the eye the retinal image is relatively smaller? This is a perceptual process which in us is a product of experience, for whereas the child's perception of the size of a given object varies within limits with its distance, the adult so far compensates for variation in the size of the retinal image that the size of the object tends to remain constant.

Again, the method of experimentation is simple and easily describable. The subject, in order to obtain food, was trained to choose the larger of two boxes which were placed on a table before it and out of reach. Choice was indicated either by pointing to a given box or actually touching it with a stick. Two pairs of boxes were employed, the dimensions of the presented faces being in the one case 8 by 13 centimeters versus 12.3 by 20 centimeters, and for the other pair, 8 by 13 centimeters versus 10 by 16.2 centimeters (*ibid.*, p. 24).

Three subjects were used in the experiment. The author gives a detailed account of the method of training the animals as well as of conditions of observation and variations in behavior during training and during the regular experiments. Various check and control experiments were performed to establish the reliability of the observations. It was proved, according to Köhler's statement and inferences, that the chimpanzee, after learning to choose the objectively larger of two boxes thus presented, will continue to choose the larger box when it is so placed in relation to the smaller that its retinal image is actually the smaller.

Thus it appears that in the chimpanzee the visual stimuli are supplemented by certain cortical processes which render the perception an adequate basis for adaptive response. That the results of this experiment are at once surprising to the comparative psychobiologist who is accustomed to observe the visual responses characteristic of lower vertebrates and also of unusual interest and theoretical importance is obvious.

A third type of question relates to the characteristics of perception of achromatic light. Here again, constancy of the perceptual configuration is in question. The human observer is able to identify a white

surface as contrasted with a black surface, even when the two are so illuminated that their stimulus values are reversed. In other words, the white continues to be identified as white, although it actually appears darker than the black. Is the chimpanzee also capable of perceiving surface colors and of recognizing, discriminating, and selecting objects, irrespective of relative illumination?

As in case of the experiment on perception of size, conditions were so arranged that the subject faced two food boxes, the one bearing a white front, the other a black front. The animal was trained to select the white in order to obtain the reward. After this lesson had been thoroughly learned, the experimenter suddenly changed the illumination of the stimulus surfaces by allowing direct sunlight to fall on the black surface (*ibid.*, p. 47). It was thus rendered relatively the lighter and the white surface relatively the darker. Despite this radical change in stimulus values, the chimpanzee, by continuing to choose correctly, demonstrated its perception of the surface appearance as contrasted with the actual illumination of the two stimulus areas.

The experiments on perception of depth, size, and surface appearance, which we have thus briefly and inadequately described, constitute the principal materials of Köhler's first report on optical studies from the Canary Island Anthropoid Station. Undoubtedly it is one of the most important contributions to the comparative psychophysiology of perceptual processes.

In yet another paper, Köhler, although concerned primarily with the problem of response to absolute versus relative perceptual values, contributes most importantly to our knowledge of certain aspects of visual perception (Köhler, 1918). Underlying the inquiries which are reported is the assumption that the chimpanzee is capable of responding to the structural or relative values of perceptual data, and that this type of response may appear either to the exclusion of response to the absolute value of the data or in addition to it. This general statement will be clarified by description of Köhler's initial experiment to test response to structure, or, as we prefer to call it, configuration.

Using Zimmermann's neutral papers as reflecting surfaces, Köhler arranged to present, in essentially the same manner as for the previously described experiments on depth and surface appearance, pairs of reflecting surfaces which differed markedly in luminosity. The numbers 1, 5, 24, and 49 designate the Zimmermann papers actually used, and they represent, respectively, white, light gray, dark gray, and black. By using different pairs of these the investigator demonstrated, first, the easy acquisition of ability to discriminate between the members of any paired combination in favor of the lighter stimulus area, and, second, ability to respond to any given stimulus either positively or negatively in accordance with its association. In other words, if, after a series of choices of light gray as contrasted with dark gray, the dark gray were suddenly associated with black, it would ordinarily be chosen instead of rejected; whereas if it were suddenly associated with white, it would be rejected instead of chosen. Thus, according to the investigator's reported observations, the chimpanzee exhibited ability and tendency to respond to the relative or structure-function value of a stimulus, instead of to its actual, absolute, or independent value. Choices by absolute value were not lacking, but Köhler maintains that responses to relative or configurational value dominated. The sudden change of a given stimulus area from positive to negative at times startled the subject and caused delay in response (1918, p. 43). Occasionally the animal promptly chose the stimulus which had formerly been the lighter, but again the adjustment to the changed situation occurred promptly.

Absolute versus relative response was further studied by means of pairs of chromatic stimuli. The stimuli and their presentation we have already described on page 315. Having demonstrated to his satisfaction the ability of the chimpanzee to

discriminate certain pairs of chromatic stimuli, Köhler arranged, as in the case of the nonchromatic experiments, for such recombinations of elements that a stimulus which for a time had possessed positive value, was suddenly given negative value, or, differently stated, from the stimulus to be chosen, was suddenly transformed by its new association into the stimulus to be rejected.

Under these conditions of chromatic stimulation and accompanying perception, the chimpanzee sometimes responded to the absolute or learned value of a stimulus, but more frequently, we are told, it responded instead to the relative value or structure-function, and consequently chose correctly where failure might naturally have been expected.

Objects differing in size served still further as means of testing the existence of configurational versus absolute response. Areas measuring 9 by 12 centimeters, 12 by 16 centimeters, and 15 by 20 centimeters were used in varying combinations, in accordance with the experimental procedure already outlined (1918, p. 55). Both types of response appeared, but again it is stated that the relative instead of the absolute value of a stimulus tended to dominate.

As one reads Köhler's detailed descriptions of his experimental apparatus, procedure, and observations, he is impressed by the fundamental similarity of the responses of the chimpanzee to those of man, the probability that this similarity applies to certain essential characteristics of perceptual processes, and by the author's obviously strong bias in favor of the Gestalt theory, with its supporting response to structure-function. We should not criticize destructively or even unfavorably the principles of experimental procedure, but we nevertheless predict that in the hands of an unbiased observer they might very well yield more abundant evidences of absolute response, and perhaps indicate to a far greater extent than is suggested by Köhler the tendency of response to structure-function or relative value to be speedily acquired by an animal which is thoroughly accustomed to the experimental situation and interested solely in success.

We have previously referred to Köhler's contributions to visual perception in the chimpanzee as epoch-making. The fact, although obvious when his work is compared with that of most other investigators, deserves reiteration. The psychobiologist may safely be promised more profit, as far as knowledge of perceptual processes is concerned, from the reading and rereading of Köhler's optical studies than from similar examination of the entire earlier related literature. It is peculiarly interesting that even before the publication of Köhler's second optical study, there had been undertaken by Kohts in Moscow a still more intensive and thoroughgoing study of vision and of varied aspects of visual perception in the chimpanzee. It remains for us to characterize the methods of Kohts, to summarize her results on visual perception, and to evaluate her contribution in comparison with that of Köhler.

The admirably simple experimental method and technique of Kohts we have described on pages 316 ff. The method is designated as selection by choice from sample, or, by matching of sample. It has the remarkable advantages of being endlessly variable, of yielding results rapidly, and of being subjected readily to a variety of controls. As contrasted with most of the methods employed by Köhler, it has the obvious disadvantage of requiring a relatively long period of preliminary training. There is also the probability that many chimpanzees would not succeed in this preliminary training and consequently could not be used as subjects, for it appears that success results from something akin to an understanding of what the investigator desires or requires of the subject. But whereas Köhler's method of experimentation may be less laborious initially, in the end it probably is much more tedious and time-consuming than that of Kohts. Köhler, in the course of years, made only a few hundred observations bearing on perceptual proc-

Fig. 105. "Ioni" at work in Mrs. Kohts's laboratory in Moscow. From N. Kohts, 1923.

esses, whereas Kohts in a few months made thousands. We do not mean to imply that this is a measure of value.

Kohts thus briefly describes the scope of her work and justifies the statements which we have just made.

> It is sufficient to mention briefly successive series of diverse performances which were carried on by this method in a surprisingly short time: the discrimination of achromatic and chromatic colors, the recognition of manifold "planimetrical and stereometrical" figures, discrimination of different volumes and surfaces, of length, breadth, height; the recognition of color combinations, alphabets, pictures of objects. Several modifications of method warranted a definite position as to question of ability of animal for elementary abstractions. Modification of conditions of experiment and consequent change in performance of animal furnished real criterion for evaluation of different factors which favored correct solution of given problem or eventually hindered, and thus exhibited the psychological character of functions of animal. (Kohts, 1923, p. 463.)

Again, with praiseworthy conciseness, the author has summarized the results of her varied observations on visual perception.

> The following things were found. The chimpanzee distinguishes thirty different chromatic colors. Of these six are shades of red, four orange, three yellow, three green, two sky-blue, three blue, six violet, and three purple. He distinguishes twenty colors when they are shown simultaneously when the objects are mixed up. He distinguishes two color combinations made of any of the above colors, provided one makes the experiment repeatedly. He distinguishes three color combinations, five grades of intensity of achromatic colors; distinguishes drawings of objects and letters. He distinguishes seven different planimetric figures which are approximately of the same size; thirteen planimetric figures equal in area—circle, oval, twelve-sided polygon, ten-sided polygon, eight-sided polygon, pentagon, square, rectangle, triangle, rhombus, trapezium, sector, and half of a disc; ten stereometric figures—sphere, cylinder, cone, cube, three, four, and six-sided pyramid, three, four, and six-sided prism; finer combinations of planimetric figures, provided there are not as many shown at the same time; four different shapes of ovals, five of polygons, five of triangles, three of rectangles, four of trapeziums, three of rhombus, and four stereometric cones. He also distinguishes size; five different heights of simultaneously presented hemispheres, each differing seven millimeters in diameter. He distinguishes an interval of twenty-two millimeters if five objects are shown simultaneously.

He distinguishes the interval of thickness of five millimeters when five objects are presented. He distinguishes the interval of length of eight millimeters if six objects are presented simultaneously.

Fig. 106. Perception of form. From N. Kohts, 1923.

He distinguishes the interval of width of five millimeters if five objects are presented simultaneously. He distinguishes the difference of areas and volume of seven millimeters if at once ten objects are presented.

It must be added that smaller objects are more easily distinguished than larger objects. It must be also mentioned that the shape of objects was distinguished also by the aid of touch when the chimpanzee had to get the object with his one hand from the depth of a bag.

The results of these experiments show that the chimpanzee is capable of diverse complicated, exact, and fine visual perceptions which are comparable to those of a child of the corresponding age, and far in excess of what the animal needs in his natural life. The chimpanzee forms ideas. He possesses ideal-motor perceptions. Very easy are associations by apposition which are difficult of dissociation. Considerably more difficult is the first association of identity, but once established the process is easily applied by analogy to diverse groups of characters. The act of recognition is accomplished in a very short time even in complicated problems, a fact which speaks in favor of the presence in the chimpanzee of a concentrated voluntary attention. Correspondingly, he is very quickly tired. Very difficult are associations by similarity. He is capable of elementary abstraction, abstraction of color from size and shape, of shape from size and color. But higher abstractions have been unsuccessful (counting). (Kohts, 1921.)[1]

[1] For this free translation from the Russian of Kohts we are indebted to Professor Alexander Petrunkevitch.

The technical procedure of Kohts is such that, although errors of observation are readily possible, they may with equal facility be avoided or controlled. Seemingly the investigator took great pains to eliminate irrelevant cues and to compel her subject to discriminate on the basis of visual perception of the objects from which the sample should be matched. In general, her results reveal more refined visual discrimination than might be expected from previous and comparable studies with other mammals. The results, therefore, much more closely approximate those for man than would be anticipated.

As to the relative values and contrasts in the studies of visual perception made by Kohts and Köhler, this may be said. Whereas the descriptions by Kohts are lengthy and full of detail concerning facts of behavior, those of Köhler are relatively brief as to observations and much more lengthy as to hypothetical conditions, theoretical considerations, and implications and interpretations of results. The contrast is at once striking and important, for undoubtedly it indicates the mental characteristics and acquired interest and technical equipment of the investigators. The contribution of each is extraordinarily important;

Fig. 107. Perception of form. An error in matching sample. From N. Kohts, 1923.

neither can be placed first. The one may be safer as an observer, the other more imaginative, ingenious in formulating problems,

and perhaps also less patient in the accumulation and evaluation of facts.

Numerous other aspects or forms of perceptual process, other than those mentioned in the foregoing pages, have been observed, commented on, and partially described by either Köhler or Kohts. Among these phenomena are perception of space, time, weight (of lifted objects), number, and varying configurations, as, for example, of an object placed in varying relations to its environment, or of an assemblage of objects (boxes, sticks, stones) arranged as a constructional unit and constituting a configuration. For further enlightening information concerning the nature of such aspects of perceptual processes in the chimpanzee, the reader is referred particularly to Köhler's studies in intelligence (1917, 1925). At this point we would, however, quote certain of this author's generalized descriptions and conclusions. We shall begin with perception of parts versus wholes.

It appears from our several observations that there need not be any actual connexion (in the technical sense) besides the (to the chimpanzee) apparent (optical) connexion, and that one object does not have to be "really" part of another, in order that the chimpanzee should regard it as if nailed to its surroundings, and not notice it at all as an independent object. If one places any implement—a window-grill, a compact table, etc.—in such a way that this object becomes as far as possible optically an integral part of its surroundings: for instance, if the table is placed carefully with one of its corners in the right angle of a room, and the flat window-grill against a wall, so that it joins it completely: one will see the chimpanzee, in search of implements, pass by this object, as if it did not exist. The object is not hidden in this case, it merely forms with its surroundings a perfect integral whole. I have not been able to make many such experiments, for the simple reason that I did not wish for the moment to hinder attempts at solution, but, on the contrary, to favour them to a certain extent by circumstances. Every experimenter will probably, for the same reason, without much hesitation avoid putting the box, for example (which may come in as an implement) into the corner of a room so that it becomes visually part of it. But if one is seeking a theoretical explanation, then once we know what the chimpanzee can do, every experiment in which we succeed in preventing the usual solution is of the greatest importance. (Köhler, 1925, pp. 115-116.)

The behavior of the chimpanzee aroused in Köhler strong interest in its perception of and adaptation to spatial relations and what may be called "statics." Concerning the subject the author remarks:

I will give only a brief suggestion of the manner in which the habits of the chimpanzee positively hinder the evolution of statics. We know that in human beings the absolute visual orientation which makes complete reversal appear as a strong alteration only, develops gradually in children. The hypothesis that this (normal) *absolute spatial orientation,* this fixed "above" and "below," is a product of the *habitual* upright posture of our heads, appears plausible, whether we wish to attribute the formation of these phenomenological facts to "experience," or (like the author) are inclined to admit a direct physiological influence of gravitation and optical stimulation of shapes on certain parts of the working nervous system (as in this upright posture). In any case, we should not have developed *this absolute orientation in space* to such an extent, if we, like the chimpanzees, held our heads just as often in other positions as vertically erect. If we consider the fundamental dependence of our statics on the, in general, firm orientation of "above" and "below," the vertical and horizontal (a child too has no statics as long as it lacks this absolute orientation), it will be evident that the chimpanzee lives under very unfavourable circumstances to the development of statics.

On the other hand his natural life is eminently calculated to exercise the functions of the labyrinth and cerebellum, and to make him so muscularly dexterous and agile that the least expert acrobat among chimpanzees need not fear human rivalry. Thus in the manipulations with ladders and boxes, he lacks a powerful incentive to the development of statics, for he is physically able to cope with structures to which no human adult would trust himself. (1925, pp. 168-169.)

Finally, we would direct attention to the following question-provoking account of the chimpanzee's "handling of forms":

In all intelligence tests which apply to an optically given situation, the subject of the experiment has—if one watches in detail—among other tasks, to grasp certain forms and *shapes* ("*Gestalten*": v. Ehrenfels, Wertheimer). These factors of form in most of the experiments described have been of the simplest, so that the uninitiated hardly recognize the characteristic properties of "shapes" (*Gestalten*) in them: sheer distances (very often), the relation of sizes to each other (in the experiment with the double stick, the relation of the two openings), crude directions and at the most

the components of direction (model experiment of the preceding chapter, experiment with door, etc.). But always where a problem of form made greater demands on the animals—i.e. where, untheoretically, one would for the first time speak of forms and shapes (in the narrower sense)—the chimpanzee began to fail, and, regardless of fine details in the structure of the situation, to proceed as if all forms were *"en bloc"* without any more precise structure. This occurred in the experiment with the wound gymnastic rope, with the coiled wire, and in building with boxes. (Köhler, 1925, p. 235.)

Much is known concerning perceptual processes in the chimpanzee; many problems have been glimpsed, several have been definitely formulated, and a few have been solved. Whereas heretofore in the preparation of this volume we have been disappointed and discouraged by the paucity of significant and reliable observational data, in this chapter we have been made to feel the pressure of abundant materials. Although the difficulties of our task of exposition have increased, the change is delightful. With a sense of incompleteness, and reluctantly, we conclude this chapter on aspects of perceptual experience and response.

CHAPTER TWENTY-SEVEN

INTELLIGENCE OF CHIMPANZEE: OPINIONS AND METHODS OF INQUIRY

THE preceding chapters on affective experience and its expressions, sensory and perceptual experience, and associated behavior, are introductory and preparatory to our chapters on intelligence. In this exposition we are proceeding on the assumption that affectivity, as experience and behavior, precedes and is basic to intelligence. Further, that it is a function of structural maturation, and although in varying degrees adapted to the requirements of the life of a species, it is not promptly and highly adaptive. In the literature on animal behavior the overt expressions of affectivity are usually termed impulsive, reflexive, or instinctive acts. A second assumption now in point is that cognitive (intelligent) behavior is phylogenetically and ontogenetically more recent in origin than affective, dependent upon a different neural mechanism (the neo-pallium), and initially unadapted, but in varying degrees and at varying rates adaptive in the course of individual experience. To describe affectivity and intelligence separately is grossly misleading, because they commonly and constantly appear together in behavioral patterns, some of which we commonly designate instincts and others habits.

It will be assumed, then, even when not so stated, that the modes of behavioral adaptation and the individual acquisitions which are described in the present chapter, imply a groundwork of responsive capacity. Although in few instances can the primary maturational contribution which prepares the way for a habit be fully described, it nevertheless appears eminently worth while to attempt a general account of those individual acquisitions which are commonly thought of as expressions of intelligence. If we were asked at this point to define the term intelligence, we should be inclined to use the phrase, individual behavioral adaptation on the basis of experience. And we by no means should object, even in this connection, to the tentative use of such partial synonyms as brightness, alertness, docility, educability, sagacity. To the consideration of what these terms suggest to the reader we would now give attention, and in still further preparation for examination of the techniques and results of experimental inquiries, we would attempt to set forth the consensus of opinion concerning the degree of intelligence of the chimpanzee.

As far back as we may definitely trace knowledge of this ape it seemingly made the impression on human observers of extraordinary alertness and sagacity. We shall not present the history of opinion, but shall permit Rennie to express the naturalistic view of a century ago.

> In this respect [nature of arborealness], it will be afterwards seen that he differs essentially from the orangs, as he appears likewise to do in his more active habits, social disposition, and superior intelligence. The circumstances of his building or inhabiting huts, residing on the ground, and living in society, elevate this animal materially above the sluggish, solitary, and arboreal orangs of the Indian isles, and countenance the probability of his occasionally erect attitude and biped progression, and even of his presumed use of a club to attack or defend himself; a circumstance, perhaps, rendered necessary, in consequence of the smaller development of his canine teeth, as compared with those of the orangs and gibbons. In short, all his actions and habits, as well as his physical structure and mental endowments, combine to elevate him above the other simiæ, and to place him in a station inferior only to that occupied by man himself, in the scale of animated nature. (Rennie, 1838, pp. 79-80.)

One should recall, as he reads Rennie's statement, that he was unfamiliar with the gorilla and that comparison is between the

chimpanzee and the Asiatic anthropoids, especially the orang-outan.

Native opinion very definitely places the chimpanzee next to man in order of intelligence. Several excellent authorities might be cited. We mention a few only. Savage and Wyman (1847, p. 425), Gautier-Laboullay (1858-61, p. 90), Reade (1864), and Jenks (1911, p. 58), all inform us that the chimpanzee is said to be more intelligent than the gorilla. "If you throw a spear at the *njina* [gorilla], say the natives, he will spring out of its way; but if you throw one at the *nchigo* [chimpanzee], he will catch it in his hand and throw it back at you." (Reade, 1864, p. 184.) Because of their consistency, and also on account of the unique opportunities which the natives have for observing and comparing the characteristics of man, chimpanzee, and gorilla, we take their opinions seriously.

Among trainers of wild animals, keepers, and directors of zoölogical gardens, and those who otherwise are intimately associated with trained and untrained exhibition specimens of chimpanzee, the opinion prevails that it probably is the most readily educable of all infrahuman animals. Some few authorities would take exception to this statement, but the majority, as indicated by published opinions, would rank the chimpanzee next to man in intelligence.

Travelers, hunters, and collectors, who undoubtedly in many instances are profoundly influenced by the opinions and superstitions of the natives, tend generally to give the chimpanzee first place. Thus, for example, Barns (1923, p. 133) thinks that study of the gorilla has shown it to be less intelligent than the chimpanzee or orang-outan, but he nevertheless considers knowledge incomplete and otherwise unsatisfactory.

The most recently expressed opinion of a specialist in morphology is that of Sonntag, who says:

> There appears to me to be no doubt that the Chimpanzee is the most intelligent of the Anthropoid Apes, but there are individual differences in the degree of intelligence. Sally, the famous Chimpanzee belonging to the Zoological Society, had a higher degree of intelligence than her successors. Young animals have a good memory for faces, and they will remember a person who has injured them. (Sonntag, 1924, p. 90.)

When we began to assemble opinions on the intelligence of the chimpanzee we were under the impression that the gorilla was commonly ranked as its superior. It considerably surprised us to discover the prevalence of the opposite view. Certainly in recent time there has been prevalent among morphologists, systematists, and certain students of behavior, a suspicion that the gorilla ranks next to man in mental development. Possibly this surmise is due to more pronounced resemblances in the structure of the nervous system, but it is quite as likely based on relative ignorance of the behavioral characteristics, and especially of the educability, of the gorilla, and is favored by the human tendency to expect the remarkable. But whatever the facts with reference to the grounds of our initial mistake, it is entirely clear from the literature that the intelligence of the chimpanzee is generally deemed superior to that of the gibbon, orang-outan, and gorilla, and second only, among existing types of organism, to that of man.

So much then for opinion, based perhaps as largely upon hearsay as upon personal observation. It now becomes our task to discover what are the facts concerning chimpanzee intelligence. At the outset we face, and it seems desirable that we attempt to answer, the inevitable question: How is it possible to discover, and having discovered to measure and accurately to describe, the characteristics of intelligence? In view of this obviously important expositional need, we shall devote a few paragraphs to methodology. Therein we shall consider general aspects of the problem of intelligence, the nature and values of certain ways of obtaining information, characteristics of the chimpanzee which primarily affect observation, and finally the handling of incentives or motives. We disavow intent to consider these subjects thoroughly. The best we can

do briefly is to indicate a few especially important principles and requirements in method.

Generally stated, the problem of intelligence is analysis of individually achieved adaptations of behavior, with intent to discover and describe modes of adaptation, their characteristics, relations, and values. In the chimpanzee we assume ability to profit by experience, since an array of naturalistic and experimental data establishes the existence of such capacity. We therefore are intent on discovering how, and to what extent, the animals profit by experience. Are they capable of perceiving and integrating relations and of acting with varying degrees of insight or understanding as are we? Does their adaptive behavior indicate the existence of analysis, abstraction, generalization? Are they capable of imitating one another or other animals understandingly? Or, by contrast with these possibilities, do they act as many infrahuman mammals and other vertebrates are said to do, without insight or foresight, and adapt to circumstances or solve environmental problems only by reason of the gradual elimination of the useless or harmful and the resulting selection of profitable acts? In a word, the essential problem of intelligence in the chimpanzee is one of insight and understanding; its presence, nature, frequency of appearance, and degree of development.

Consequently it is pertinent to inquire how the student of the chimpanzee may investigate individual adaptivity in order to discover whether or not it involves insight? This question is capable of very brief answer, although description of the varied methods which have been utilized, and discussion of important aspects of procedure would lead us far. In its bare essentials, the method of studying intelligence involves presentation to the subject of a situation which demands some unusual, and therefore neither innate nor acquired, mode of behavior. Usually this is spoken of as the presentation of a novel problem, in order to discover whether the animal is capable of solving it, and if so in what manner. Problems, in varying degree novel and difficult, we know from our own experience to be of endless variety. The number which may be devised for and presented to chimpanzees is limited only by the ingenuity, time, and patience of investigators. We would mention as examples a few types of problematic situation which have more or less frequently, and with varying degrees of profit, been employed in the exploration of what we have called chimpanzee intelligence.

There is first what is commonly called the discrimination method. It involves the presentation of two differing stimuli, of which the investigator designates the one as positive and the other as negative. Effort is made by presenting these pairs of stimuli under certain controlled conditions to discover whether the subject can react appropriately by indicating choice or selection of the positive stimulus, with which is associated some incentive, as, for example, food, escape from isolation to companions, or opportunity for play. The negative stimulus, on the contrary, yields no satisfaction, but instead its selection ordinarily necessitates a repetition of response. The paired stimuli may be endlessly varied, as, for example, in quality, intensity, complexity. Lights, colors, sounds, odors, objects differing in size, form, or distance may be employed. Ordinarily this method serves especially well to indicate ability to respond to specific stimuli, to measure the amount of difference between stimuli necessary for discrimination, and to analyze roughly the nature of perceptual processes. It may be used for the investigation of any or all sense modes and for many if not all aspects of perception which appear in connection with the several sense modes. In the previous chapter we have had occasion to describe and characterize the method briefly as used by Köhler in his studies of visual perception.

A somewhat more complex form of the discrimination method was employed by Kohts under the name choice by matching of sample. In this instance the positive stimulus, instead of being relatively simple,

appeared in a varying group of objects, and it was to be recognized, selected, and presented to the experimenter. Evidently in the use of this method a certain approach to insight or general understanding of the requirement of the experiment is essential to success.

A second type of procedure, varying radically from the discrimination method, is commonly designated as the maze method. Although very extensively used for quantitative studies in habit formation, or modifiability of behavior, in rodents and certain other mammals, it has been relatively little used with the primates, and only in rare, unusual forms for the chimpanzee. This method presents a subject with the necessity of finding its way, variously guided according to experimental conditions, from some constant starting point to a certain fixed goal at which reward is achieved. The path which must be followed is rendered more or less complex and baffling by the introduction of turns, blind alleys, and various sorts of obstruction. There are, for instance, mazes in which electrodes are introduced for stimulation of the animal when it takes a wrong path, others in which areas of water appear as barriers or baffling features. As in the case of the previous method, there is indefinite opportunity for experimental ingenuity in the handling of this procedure.

A third type of method long used after introduction by Thorndike, especially by American investigators, has often been called the problem-box or puzzle-box method. As the name suggests, it involves such arrangement of an experiment box that it serves to present a problem to the animal. Usually the motive depended upon is the desire of the animal either to escape from or get into a box. As a rule, food is employed as incentive. Types of problem, varying extremely in naturalness, complexity, and ease of solution, include the fastening of door or exit barrier so that it will not open unless some mechanism or series of mechanisms within or without the box is actuated. Strings, plugs, latches, bolts, levers, locks, singly or in combinations, have been employed in problem boxes in the study not only of other mammals but also of the chimpanzee.

Although various other types of method or variants of the above types might be listed, it is our purpose in this connection merely to indicate certain methodological essentials in the study of chimpanzee intelligence. Therefore we ask attention to a valuable discussion of this subject by Köhler, and supplement the points which we have already made by a summary of his contribution.

The article in question, prepared for Abderhalden's handbook of biological methods of research, is concerned with methods of psychological investigation of the anthropoid apes, but since Köhler had himself worked especially with the chimpanzee and was relatively unfamiliar with other types of anthropoid ape, we take it that his ideas and recommendations concerning method are based primarily on his experience with the chimpanzee, and that his discussion, therefore, may be most appropriately and profitably examined in the present chapter of our work.

Our reference is to Köhler (1921a). Ordinarily we shall not refer to pages, since the entire article is of extraordinary importance and should be read by every psychobiologist who proposes to use the chimpanzee for experimental studies in behavior.

In commenting on the requirements and values of methods of investigating intelligence Köhler points out that problems may be arranged for independent solution on the basis of individual initiative or of imitation. In either case it is of the utmost importance that the nature and degree of difficulty of the problem be determined in accordance with observation of the characteristics of the organism, the individual to be studied, and not in accordance with the characteristics, demands, or possibilities of human experience. In other words, the problem should be fair to the animal for which it is designed. It must not be too easy nor too difficult. Köhler evidently believes that

many methods of animal experimentation, and many problems designed for the testing of animal intelligence, are obviously unsuitable and prove the stupidity or inadequate knowledge and insight of the investigator. It is undeniable that human characteristics and experience tend overmuch to influence the nature of problems designed for the investigation of animal intelligence.

A second essential set forth is that the situation which involves a problem to be solved should be wholly and readily accessible to the senses, unless perchance the particular problem under investigation demands a different condition. For if, as in many problem-box situations, a mechanism is used which cannot be clearly or completely seen by the animal, solution or adaptation by insight or understanding, although otherwise possible, may not reasonably be expected. Again, following the same line of thought, our author stresses the necessity for simple, clear-cut situations which may be readily perceived. This contraindicates intricate mechanisms or complications such as are often arranged to puzzle human subjects. Köhler evidently would definitely exclude, as means of discovering insight, problems which are in the true sense puzzles.

The animal must come to the experimental problem without previous experience or practice. In other words, the problem must be new and unsolved; otherwise, prompt solution may appear on the basis of previous experience, and the investigator may misinterpret it as evidence of insight. In this same connection, chances of imitation either of the experimenter or of other chimpanzees must be carefully excluded. Finally, in summing up precautions, Köhler says that accidental solutions must be guarded against, for often what may look like a good solution to the inexperienced or overexpectant observer, may be purely accidental and due to the application of a previously learned response to the present experimental situation.

The chimpanzee is recommended as peculiarly suitable for experimental studies in psychobiology. It is necessary, Köhler says, to take into account individual and specific characteristics, age, health, social relations, the immediate physiological condition of the subject, including appetite, effects of past experience, and, in general, the conditions affecting and determining motivation.

As special requirements in connection with measurement of intelligence in the chimpanzee, Köhler stresses careful observation and description; the factoring or phrasing of behavior, that is, relating essential parts of the solution of a problem to the immediate conditions for their occurrence; the consideration and appraisal of failures, some of which may, as he says, be "good"; judgment concerning the psychological characteristics of an act in terms of its adaptive value and relations to the situation instead of in accordance with its resemblance to human behavior, and attention to the way in which the subject meets and solves subproblems or minor difficulties arising in the course of an experiment.

In the light of discussion of methods for studying sensory discrimination and perception, Köhler points out the possibility of general as contrasted with specific training as basis for experiments. Instead, for example, of training a subject to choose a particular large box as contrasted with a particular small one in order to obtain food, by proper procedure it may instead be taught to choose the larger of two boxes, or, by different procedure, it may be taught to match a given box from a collection of objects placed before it. Generalized training, as the author very well insists, is advantageous, since it saves time and avoids unduly taxing the patience and interest of the subject. Obviously it is desirable to minimize what Köhler calls mechanical training and wherever practicable to substitute for it a generalization on the part of the animal. It is further proposed by Köhler, and we believe the proposal is entirely practicable, that in studies of chimpanzee intelligence extensive use should be made of ability to respond to structure-function or

the relative value of a stimulus, object, or situation, as contrasted with its particular or absolute value.

The systematic discussion of methods of psychological investigation of anthropoid apes, which we are attempting to summarize, concludes with the enumeration of seven important desiderata. We list them below by number, with brief descriptive comment.

(1) Simplicity of apparatus. Since the chimpanzee is capable of manual operations, and also psychobiologically capable of learning to use a stick, for example, as tool, the desirability is indicated of teaching the animal to react by pointing with hand or stick to the object chosen, in indication of its response to a situation, instead of by general body movement or locomotion.

(2) Varied sources of error must be guarded against in work with chimpanzees as with other animals. Extraneous cues, if present, should be controlled; in many instances they must necessarily be eliminated. The influence of the experimenter must be considered, and, if discovered, be checked or controlled to an extent which renders definitely interpretable results possible.

(3) The subject of observation, within reasonable limits, must be protected from distractions and annoyances which tend to waste its energy, and all necessary precautions must be taken to maintain its interest in the problem and its desire to succeed.

(4) The number of observations per day should be so limited that interest shall not seriously diminish. It is relatively easy to fatigue, discourage, or bore the animal by too frequent presentation of a given problem or by too many repetitions on any given day. On the whole, too few rather than too many observations per unit of time is to be recommended.

(5) If variations of a problem or experiment are made they should not follow one another too rapidly, since confusion is likely to result. It is better to allow a long interval between variations than to attempt to hasten the work.

(6) Whereas certain mammals, such for example as the rodents, seemingly work very well in such monotonous and presumably unintelligible forms of experiment as "sensory discrimination" and "the maze," the chimpanzee tends to work impatiently and on the whole less successfully. Apparently for it, the use of these methods, unless very definitely required by a given problem, is contraindicated, and in place of them it is desirable to use situations which permit of attentive observation and such measure of insight or understanding as the chimpanzee may be capable of. Furthermore, and of this Köhler makes much, it is desirable to do everything possible to make the problem intelligible to the subject and thus to enable it to grasp the essential relations or factors which condition solution. To this end, striking contrasts may be introduced, as, for example, in color, size, form, spacing, and the experimenter may definitely and repeatedly call the attention of the subject to significant aspects of the situation.

(7) Finally, we are reminded that despite the conspicuous importance of some one act or aspect of behavior, the total behavior of the subject should be taken into account and carefully recorded for analysis and interpretation. By way of illustration, although the selection of the correct box directly and immediately may seem the essential thing, the attitude, facial expression, hesitation, evidence of recognition, and other similar features of behavior, may be even more important for an understanding of the animal's adaptation than the fact that it succeeded promptly in making a correct choice.

We would now supplement Köhler's description of points in methodology by mentioning certain characteristics of the chimpanzee, and also aspects of motivation, which are of peculiar importance in studies of intelligence.

On the whole, the temperament of the chimpanzee is favorable to experiments, for the animal is alert, attentive, active, and keenly interested in objects and events about it. In healthy contented condition and

with wise care and handling in experiments, it tends to observe and investigate, test or try, manipulate and seek in various ways to use to its own advantage, everything within reach. Although left to itself a subject may be extremely destructive, in the presence of the experimenter there is slight indulgence in this tendency, and curiosity expresses itself primarily through observation and manipulation. There are extreme individual, sex, and species differences, and the same subject varies in mood, exhibition of interest, willingness to work, attentiveness, alertness, and seemingly also in insight from day to day. All of these facts are readily observable, and the investigator should have no particular difficulty in adapting to them and in utilizing them in the achievement of his ends. There is, however, another group of facts having to do with the characteristics of the animal which is of extraordinary importance for successful experimentation. We refer to motivation.

Although the term motivation refers to the psychophysiological condition of the organism which impels it to act in various ways for the attainment of some more or less definitely recognized and desired goal, the words incentive, reward, lure, more frequently occur in the literature as designation of motivating conditions. At this point we would indicate that, as far as an experiment is concerned, motivation is influenced by two types of external factor or condition. They may well be described as positive conditions and negative conditions. In the first category we may mention food or other desired object; freedom or escape to a more restful situation; companionship of members of the species or of other animals; play, amusement, or entertainment. The list may be extended, but these conditions will at least serve as typical examples. The second category includes such conditions as failure and disappointment in an experiment; delay, waiting, and necessity for repetition of activities; confinement or restriction of activity; reprimand or scolding; physical punishment as by whipping or electrical stimulation. Again we have presented examples without completing the list. The one of these categories we have described as positive because the conditions tend to attract or pull the animal in a certain direction and thus to encourage or induce it to perform a certain act, solve a certain problem, or adjust to a certain experimental situation. Thus the subject endeavors to use a stick in order to obtain food, or by opening a door to escape to freedom, companionship, or to achieve definite opportunity for play or amusement. By contrast, certain other conditions are negative because in order to avoid them the animal endeavors to do perhaps precisely what the positive conditions drive or encourage it to do. Thus in order to avoid the discomfort of failure, the necessity for repetition of its endeavor, confinement in the experimental situation, scolding, or an electric shock, the animal does its best to solve a problem.

In the paper which we have summarized, Köhler (1921a, p. 74) advises against compelling the chimpanzee to work in the absence of natural interest, and he well says that repetition of a mechanical or relatively meaningless activity rapidly destroys spontaneity and the customary lively interest of the subject. In studies of intelligence this effect is fatal to the success of the experimenter in discovering the maximum adaptive ability of his animal. Also in various of his publications Köhler has emphasized the importance of positive incentives or motivating conditions and the relatively smaller value or actual lack of value in negative conditions. We quote a sentence: "Punishment, which in the study of lower animals often may follow an incorrect choice or reaction, in the study of the anthropoid apes is quite harmful." (1921a, p. 105.)

Although in general our experience, both methodological and observational, agrees closely with that of Köhler, in his practical judgments and advice concerning motivation we are compelled to take different ground, for our extensive experience in investigating the sensory reactions and various aspects of modifiability and adaptivity of behavior in several types of vertebrate,

and also in several of the primates, definitely indicates that both positive and negative motivating conditions can be used advantageously, and, we believe, should be used in experimental studies of the chimpanzee. Our work indeed indicates that often it is possible to combine positive and negative conditions in order to increase the strength of motivation and to prolong its life. Whereas Köhler in his anthropoid investigations has depended as far as we can learn from his reports primarily on food as incentive, and Kohts by actual statement primarily on freedom and desire to play, we have used in connection with various types of problem presented to the chimpanzee, food, confinement, delay, necessity for repetition of act, and punishment by electrical stimulation. It is indicated that negative incentives may be quite as effective as positive, and that such forms of punishment as reprimand, scolding, threatening with a whip, or electrical stimulation, either alone or in combination with positive factors, may yield excellent results. It is true, however, that like the child the chimpanzee often resents punishment and may react to it so unfavorably that its use is clearly contraindicated. It is our practical judgment that the use of negative incentives requires more information, insight, patience, ingenuity, and skill on the part of the investigator than does the use of positive incentives.

With this general introductory statement concerning the nature of the problem of intelligence, principles of method, and ways of controlling motivation, we turn to our major task of assembling and examining evidences of adaptive behavior in the chimpanzee. Instead of presenting the unusually abundant and valuable results chronologically, we have arranged them in accordance with a logical scheme which we believe will enable the reader to consider principles while noting and evaluating illustrative and supporting observational data.

Previously we have offered evidence of the general opinion that the chimpanzee is the most intelligent of infrahuman organisms. We would now indicate what appear to be supporting facts, arranging them in three major groups: (1) modes and conditions of behavioral adaptation; (2) manipulation of environment versus self-adaptation; (3) imaginal processes. Under modes and conditions of learning we shall consider imitation, trial and the elimination of fruitless acts as basis for habit formation, observational elimination of mistakes, the appearance of insight, and the development of understanding as primary condition of adaptation. In examining the evidences from use of instruments and agents, we shall consider the utilization of environment versus adaptation to environment (dual adaptation) and the nature and extent of mechanical ability. Imaginal processes will be considered under three heads: namely, memory, creative imagination, abstraction and generalization.

CHAPTER TWENTY-EIGHT

INTELLIGENCE OF CHIMPANZEE: MODES AND CONDITIONS OF BEHAVIORAL ADAPTATION

THERE are, as every intelligent observer of animals knows, various phases and modes of behavioral adaptation to internal and environmental conditions. We may not here undertake to present the subject adequately, but for our guidance in examination of the phenomena of intelligence in the chimpanzee we shall offer a simple schema, the several sections of which designate distinguishable modes, which in actual life constitute a single, although possibly irregular, course of adaptational development from the relatively simple and primitive to the obviously complex, recent, and elaborately conditioned.

We would suggest then five categories, each of which is characterized by one or more important varieties of adaptive process:

(a) Repetitional modification of initial maturational response. The activities of the mammalian fetus or infant may or may not be true reflexes. For them there is no commonly accepted technical term. They appear, and either are or, with repetition, become adaptively modified, integrated into systems or patterns, and constitute in the main the so-called instinctive, hereditary, or natural adaptations of the organism.

(b) Trial and error. This familiar expression is used to designate occurrence of acts which are perceptually guided and directed toward some goal, but seemingly fail of definite and direct relation to the goal. Adaptive progress is achieved by the gradual disappearance of profitless acts and the persistence of those which yield satisfaction. Therefore, this mode of adaptation is described as lacking insight and in marked degree accidental in its outcome.

(c) Observational elimination of acts and attentional selection of certain among various possible responses. In this case there is evidence of attention to the objective and effort to attain it. The function of previous experience is much more obvious than in either (a) or (b). Yet such measure of appreciation of relations, or of other essential aspects of the situation as might suggest the term insight, is lacking. Obviously this category marks the transition from trial without insight to response with insight.

(d) Insight and direct adaptation. This is characterized by definite selection of acts which have adaptive value and either immediately or shortly yield success.

(e) Finally, in pre-adaptive response we discover what may appropriately be called foresight. In this instance the organism gives evidence of anticipating certain events and of adjusting its behavior to them in advance.

All of these modes or phases of behavioral adjustment we may readily observe in our own lives. The question is, which of them appear in the chimpanzee? Probably in advance of presentation or discussion of facts, most psychobiologists would grant the probability that the first three of these five modes of adaptation may be observed in various primates. That adaptation with insight and foresight occurs in the chimpanzee few of us would be prepared to admit, except on the basis of convincing evidence. It is our task then to examine the facts as they appear in the somewhat extensive literature and to indicate as definitely as we may their bearing on the principal problems suggested by our classification. For simplicity, instead of using five categories of adaptation in the following exposition, we shall assemble the facts in three principal divisions: (1) conditions of adaptation as typified by imitative influences;

(2) trial adjustment, and (3) adjustment with insight.

We must dismiss with a few words the generally important, although entirely inadequately known, topic of conditions of adaptation. There are, we are aware, numerous and complex internal and external factors which influence the behavior of an organism and also the adaptivity of that behavior. The internal factors are extremely difficult to observe or evaluate; the external, although somewhat more readily accessible, are also difficult to control and in some instances difficult also to measure. Among external factors there are those which depend on physical environment, and, by contrast, those which are due to the characteristics of organic and social environment. We propose, as suggested above, to consider social influences as illustrative of conditions affecting adaptation. Although the beings which constitute one's social environment may exert many sorts of influence, there is a commonly used concept which designates a major factor or group of factors in the relations of relatively highly organized vertebrates. The concept is that of imitation. It is known that human life is profoundly affected by imitative tendency. Is this true also and equally of the chimpanzee? Does it possess, as formerly would have been affirmed, an instinct to imitate? And, if so, does it imitate blindly or with insight?

IMITATION AND TUITION

Consideration of imitation at once suggests forms of tuition or teaching, and it is apparent from the literature on the chimpanzee that social influence extends beyond natural, spontaneous reproduction of the acts of other beings to definite tuitional effort. Therefore, the concept of educability, and consideration of educational procedure, are also pertinent to our present discussion. Now it appears that imitation in organisms, like behavioral adaptation, presents various phases or distinguishable forms. Thus, for example, an organism may be attracted by the behavior of its fellow and may intently observe. This arrest of attention may or may not induce attempt to repeat the observed act. Or again, arrest of attention and observation may induce approach to the active organism and effort to keep in proximity to it. This inevitably places the observer in the same environmental region as the active organism and thereby increases somewhat the probability of reproduction of the observed type of response. It also tends to focus the attention of the observer on the same environmental object or events that occupy the active organism. Yet, despite this chain of happenings, clearly enough indicative of the influence of one organism upon another, there may be no adaptive, or otherwise profitable, reproduction of an activity. Nevertheless, we commonly apply the term imitation in such cases.

Finally, instead of such general influence as we have described, there may be prompt and obvious reproduction of the act observed, the one organism being stimulated by observation of the other to do the same sort of thing or to achieve the same result. These two possibilities are separable because in the latter case imitation is less obvious than in the former, and we consequently and necessarily distinguish imitation of end, of means, or of both. There are indeed many instances of repetitions of acts without evident relation to objective or goal, and many others in which the goal seems to occupy attention to the exclusion of the means of attaining it. Always there is the possibility (1) of lack of imitative influence, (2) attraction of attention without definite influence on the mode of response of the observing animal, (3) observation of a goal which is being sought or achieved by the active animal and of attempt to gain the same objective, or finally, (4) more or less exact repetition of the act observed with or without attention to the original goal.

It has been indicated by several students of organic imitation that since many of its forms are psychobiologically simple and possess relatively little adaptive value, the

application of the term may profitably be limited to that form in which the observing animal acts as though it understood the behavior seen and with insight and definite purpose repeated it.

In the chimpanzee, imitative influence is commonly observed. The animals are extremely sociable, interested in and dependent on one another, and almost every form and phase of the behavior of an individual is more or less intimately dependent upon the activity of the group. We might cite from our own observations and from the literature instances of all of the varieties of imitation, or approach thereto, which have been enumerated.

Frequently recorded are observations of the use of such objects as broom, brush, comb, toothbrush, stick, hat, hammer, screw driver, in ways which seem clearly to indicate the influence of observation of persons or of other primates. Tending to support the contention that the chimpanzee naturally, readily, and frequently imitates the use of unfamiliar objects are numerous observations like those now to be described. Whether this is done with insight and intent to attain a definite objective is an important question.

It is reported by Rothmann and Teuber (1915, p. 16) that certain at least of their chimpanzee subjects quickly learned to open doors and to insert keys in locks on seeing these things done. They learned also to use a lever to regulate the water supply, and in imitation of their keeper tried to scrub the floor and sweep with a broom. Likewise, Furness (1916, p. 289) records as imitative activities digging with a spade or trowel, scrubbing, sweeping, and manipulating a screw. Almost every trainer who has worked with the animal records varied evidence of so-called imitation. Thus, Sheak writes of an intelligent specimen named Joe:

> He learned to wipe his nose with a handkerchief, brush his hair with a hairbrush, clean his clothes with a whisk broom, drink out of a cup, eat with a spoon as well as any human child, bore holes with a brace and bit, use a handsaw quite dexterously, take screws out of the guard rail with a screw driver, drive nails with a hammer and pull them out with the claw of the hammer, and to play on a toy piano and on a mouth harp. (1923, p. 55.)

Naturally the reader asks whether in such instances some form of tuition does not replace or supplement imitative tendency. As if in reply, Sheak tells us that no special effort was made to teach the animal, but that "he was a close observer and persistent imitator."

We present also, on the authority of Sheak, the following interesting account of the imitative use of needle and thread.

> We once had a very intelligent chimpanzee called Sallie. A negro connected with the menagerie had a needle and thread with which he mended his clothes. Sallie watched the operation very intently. A little later she was noticed with a string trying to find an eye in a nail. She was given a small darning needle, and a heavy cotton thread, and at once threaded the needle, just as she had seen the negro do. After that she could not be deceived. When given a nail or piece of wire, she would look for an eye and, if there was none, she would throw away the counterfeit. She would begin by wetting the end of the thread in her mouth, would place the eye of her needle in line with her eye, insert the thread from behind forward, then pull the thread the remainder of the way with her lips. She often tried to tie a knot, too; but in this she was never successful. She always tried to make the knot in the thread up next to the needle. After a number of [un]successful attempts at this, she would go to work on her dress, and sew, and sew, and sew, pulling the thread clear at every stitch. Sometimes she would amuse herself in this way for half an hour. (1917, pp. 308-309.)

Numerous instances of imitation are cited by Kearton in his story of Toto, and this observer asserts that the animal was a perfect imitator and learned many things simply by watching and copying. Occasionally the observer corrected mistakes, so in the following list of imitative achievements there is a measure of supplementation. Kearton thus describes Toto's initial experience with a toothbrush and his progress in learning to use it.

> This began one day when he sat outside the tent and watched one of the boys cleaning his teeth. The native did not use a brush as we do, but a little wooden stick with a frayed and fibrous end,

which did its work exceedingly well. Toto picked this up when the boy laid it down and, like the perfect imitator that he was, put it into his own mouth, drawing it to and fro as the boy had done.

Doing this seemed to give him great satisfaction, and for several days he did it every morning. Then he began to realise that I did something a little different, and he decided upon an experiment. One morning I noticed him fumbling in my valise, and a minute later I saw that he had taken my toothbrush.

Now, though I had every desire that Toto should be well brought up and should learn in time to wash behind his ears and clean his teeth three times a day, I preferred to keep a toothbrush, at any rate, to myself. So I chased him round the tent, took the brush away, and then gave him a new one, just as it was bought, in a little paper bag.

He put it at once into his mouth, and soon became entangled with the paper. In a few minutes, however, he got rid of this and settled down to the new experience.

He found the method of the white man considerably more difficult than that of the native. He had, as may be seen from his portrait, a fairly large mouth; but that, instead of making the matter easier, rather added to his difficulties, because he was uncertain into which part of his mouth the brush should be put. First of all he brushed his tongue, and it tickled. Then he tried to eat it.

"Steady, old fellow," I said. "Watch what I do," and taking my own brush I held it up to attract his attention. Toto imitated me at once, holding the brush so that it scraped his nose and made him sneeze. (Kearton, 1925, pp. 46-47.)

In similar fashion Toto learned, primarily on the basis of imitation, to wash himself, use mirror and brush, use keys appropriately, and to smoke. The history of the last-mentioned achievement we would also present in the author's words.

One day he watched me in silence for a long while as I sat smoking. Then he came towards me and reached up to touch my pipe.

"It's an evil habit, Toto," I said, laughing. "You'd better keep off it."

But soon I found that he was serious. He wanted to smoke. So I gave him an old pipe, wondering what he would do with it. He went back to his chair, put the stem between his teeth, and leant back luxuriously, closing his eyes. For a time he seemed content, and for some days after that wherever he went he carried the pipe as if it was his most precious possession. Then he realised that I used to put brown grass into the bowl of mine and set fire to it, and he wanted to do the same with his. I let him try. The matches proved a difficulty, but at last he learnt to strike them and to light the top of the tobacco. But he did not realise the secret of the art of smoking and he was puzzled when the flame in his pipe died directly, while mine continued to send forth clouds of smoke.

It was constantly a problem for him, and often I felt that he was longing for me to show him how it was done. I tried to do so, but my drawing in of breath must have looked to him merely a matter of making faces; so that I roared with laughter when he began to imitate my expression.

Still, he played every evening with the pipe. Many months later, it chanced that he drew in his breath through his mouth while the pipe was between his teeth. He gasped. He choked. He coughed. But the secret was found, and from that night he exhausted his half-ounce of tobacco every week. (1925, pp. 53-54.)

Imitation of acts, gestures, or attitudes, as contrasted with the imitative use or manipulation of objects, is illustrated by the following instances. Spitting or expectoration in imitation of man has been mentioned, but with inadequate description of circumstances, by O. T. Miller (1887-88, p. 302), and somewhat more circumstantially by Yerkes, who remarks:

A boy of twelve who was playing with Chim in the New Hampshire pasture one day began to spit to see whether Chim would imitate him. Chim watched with keen interest and perfect attention. Almost immediately he tried to spit. His initial efforts were amusing if not effective. The following day in the observation room he was seen off in a corner practising spitting, having achieved in the meantime a fair degree of proficiency. As this performance was promptly discouraged the story stops here. (Yerkes and Learned, 1925, p. 51.)

By various observers, handclapping, postures or attitudes, lip movements and poses, as for example in boxing, have been noted. Behavior such as we have described above is so common that it seems entirely needless to offer additional illustrations. Our own unpublished notes contain much material confirmatory of the statements which are made by other observers, and we feel entirely safe in asserting, as the consensus of opinion among competent students, that the chimpanzee commonly and with extreme facility imitates acts, in some instances for the mere satisfaction of per-

forming them, and in other cases for the sake of a desired reward or objective. The imitative tendency in this ape is one of the chief aids to tuition and we believe is chiefly responsible for its extraordinary serviceability as stage performer.

The reading of Köhler's publications, and more particularly his studies of chimpanzee intelligence, may at first give the impression that he denies or minimizes the importance of imitative influence, and indeed such was our opinion of his position until we read critically, by comparison with earlier publications, a discussion of the subject written in 1926. For reasons which need not now concern us, Köhler has taken considerable pains to destroy confidence in an instinct to imitate. Because his position seems to be at variance with the facts, we quote him as follows, preparatory to further examination of his views and formulation of our conclusions from all the evidence available.

> Are not monkeys and apes endowed with a special instinct to imitate almost all acts which they see performed in their neighborhood? If, then, they do it under experimental conditions, too, what can we conclude?
>
> But in this case a widespread opinion is an absolutely wrong one, and the idea or the belief that monkeys and apes are constantly imitating the behavior of others seems to have the following origin. Monkeys and apes make a strong impression on us by some striking similarity between their behavior and the behavior of man. Don't they use their hands in the same manner as human beings? Don't their faces show similar "expressions" to those of man in many states of emotion? All this is easily explained, if the primates find a special pleasure in copying, or are mechanically compelled to copy the attitudes and the behavior of man. However, monkeys and apes who are caught somewhere in the woods of Central Africa or Asia show the same similarity with man's behavior from the first moment, before any experiences with the behavior of human beings could begin to have such an influence. The similarity with man is a natural one and does not prove at all the working of a strong "instinct of imitation."
>
> In fact, there is not such an instinct. Imitation is almost as difficult for apes and as rare in them as it is in lower vertebrates. One does observe imitation of different forms or types in apes, but not so very often, and only after certain conditions are fulfilled. One first type of imitation which I saw with surprise in chimpanzees is very well known from observation in children. When the workman has been in our house and the children have, of course, observed with greatest interest what he was doing, we may see, on the same or the following day, how the children with the help of some objects, a book, a stone, or a wooden board, are copying what seemed to them essential in the performance of the man, in sawing, nailing or boring. Let me call this behavior of children a "serious play." It *is* a play, but it is serious at the same time, as many plays of our children are,—the child feeling himself important in assuming the rôle of the artisan. If somebody laughs about the play, the pleasure in it is usually spoiled.
>
> I would call the following behavior of a chimpanzee imitation of the "serious play" type. On the playground a man has painted a wooden pole in white color. After the work is done he goes away leaving behind a pot of white paint and a beautiful brush. I observe the only chimpanzee who is present, hiding my face behind my hands, as if I were not paying attention to him. The ape for a while gives much attention to me before approaching the brush and the paint because he has learned that misuse of our things may have serious consequences. But very soon, encouraged by my attitude, he takes the brush, puts it into the pot of color and paints a big stone which happens to be in the place, beautifully white. The whole time the ape behaved completely seriously. So did others when imitating the washing of laundry or the use of a borer. (Köhler, 1926, pp. 156-157.)

The reader might very naturally infer from this discussion that our most important contributor to knowledge of the intelligence of the chimpanzee considers its imitative tendency of relatively slight importance, and believes that this ape seldom imitates intelligently, or, as he perhaps would prefer to say, inferentially. That we should misinterpret our author in so doing is clear from more careful comparative study of his various statements. Thus in his *Mentality of Apes* (1925, pp. 230 ff.), he indicates his acceptance of four kinds of imitation, but again he argues that the animals do not imitate significant acts simply, mechanically, and on the basis of instinct, but that instead, when they are endeavoring to achieve a certain objective under the influence of another animal's activity, they frequently behave with insight. In other words, as we understand him, Köhler consistently argues against what he designates simple, instinctive, or unintelligent imitation, and in favor of intelligent or inferen-

tial imitation. It appears that he is trying further to substantiate his interpretation of certain chimpanzee activities as involving insight or understanding of essential aspects or relations of a situation. Naturally if a special instinctive tendency to imitate what is seen existed in the creature and it so acted without specific influence of end or observation of means, one could not infer the presence of insight from seemingly adaptive imitational behavior.

We have taken pains to explain Köhler's statements because they readily lend themselves to misinterpretation and the reader is very likely to obtain from one or another of the paragraphs, sections, or chapters, as, for example, Chapter 7 "Chance and Imitation" of his *Mentality of Apes,* the conviction that he considers imitative tendency relatively unimportant in the chimpanzee. Actually, as we understand it, his position is entirely different and he probably would not disagree with the conclusion we are about to formulate.

Whether or not there exists in the chimpanzee any inherited tendency to repeat observed actions, we may affirm, on the basis of a very considerable body of information, that it frequently exhibits imitative responses. They range from the apparently compulsional interest in and observation of the behavior of another companion, either human or anthropoid, to definite repetition of the essential aspects and relations of behavioral means to a certain recognized and desired objective. We recognize, and we believe any competent observer can demonstrate, in the average to superior chimpanzee, intelligent forms of imitative behavior.

Imitation, as we hope we have made abundantly clear, is not a form of behavioral adaptation, but instead a condition of response. Significant of the intellectual status of the chimpanzee are the evidences of ability to profit by imitative influence and by various forms of tuition.

Varied evidences prove that this ape is highly educable. It is because of this fact that it is so frequently used as a performing animal. Gifted specimens usually may be taught many things quickly and readily by being shown what is required, or by being assisted in the performance after being shown. There is indeed a remarkable contrast in the educability of such mammals as the mouse, the cat, the monkey, and the chimpanzee. Educational procedures, such for example as showing the animal what is required, actually helping it to go through a performance, or putting it through a certain series of acts, are wholly inapplicable, useless, or positively harmful for behavioral adaptation of the mouse; of relatively slight value in case of the cat; somewhat more serviceable, although with obvious limitations, in the monkey; and preëminently useful in the chimpanzee. For peculiarly significant and useful evidences of the educability of the chimpanzee we suggest the following sources, in addition to the reports of experimental inquiries which it is our purpose to describe and discuss in subsequent pages. Broderip (1835, p. 162), Hagenbeck (1909, pp. 286-287), Knauer (1915, pp. 44, 77 ff.), Marbe (1916-17, p. 139), Heck (1922, pp. 673 ff.), Sheak (1923, p. 55).

It appears from varied and on the whole unusually reliable evidences that the chimpanzee may be trained or assisted in its behavioral adaptations by procedures which are either inapplicable or of slight value in other organisms than man and the great apes. Thus, for example, its attention may be attracted to those aspects of a situation which are peculiarly important; it may be shown how an act or series of acts should be performed, results of a course of action may be exhibited or demonstrated, and thus the way prepared for intelligent effort on the part of the animal to comply with the desire of the teacher. Tuitional practices are used by chimpanzee parents in the education of their young. Köhler, as will later appear, lays great stress on what we may rather inaptly but perhaps excusably term "intelligent" as contrasted with "mechanical" methods of animal training. It is his claim that inexcusable waste of the experimenter's time and misleading or otherwise

unsatisfactory results accrue from use, in the study of behavioral adaptivity in the chimpanzee, of methods which do not permit of the perception of essential aspects and relations of a problematic situation. Such methods he characterizes as those of "mechanical training," whereas the methods which he himself most frequently used and which he urgently recommends as peculiarly suitable for the exploration of chimpanzee intelligence, are comparable with those of child training and might very well be taken from the nursery, kindergarten, schoolroom, or laboratory.

In concluding this section on imitative influence, it is our obligation to indicate the limitation of available information. No systematic experimental study of imitation in the chimpanzee has been undertaken, still less carried to successful completion. Many sporadic observations are on record, but the field is practically open for exploration and fruitful development by the technically equipped, patient, industrious, and intelligent psychobiologist. A few experimental investigations, notably those of Thorndike, Kinnaman, Watson, Haggerty, and Kohts,[1] on imitation in monkeys, have been published, but, strange to say, aside from the types of reference which we have already cited and brief and relatively incidental contributions to the subject by Shepherd (1915, 1923), Köhler (1921a, 1925, 1926), and Yerkes (1925), there is no account of any phase or form of imitative action in the chimpanzee. The opportunity for important contribution of fact, and also for further illumination of the difficult problem of behavior with insight, is unique. It should command attention.

[1] For these references see bibliographic note on page 578.

CHAPTER TWENTY-NINE

INTELLIGENCE OF CHIMPANZEE: ADAPTATION OF ENVIRONMENT VERSUS SELF-ADAPTATION

BEHAVIORAL adaptation on the basis of selectional trial and without perception of relations undoubtedly occurs in all mammals, if not also in all vertebrates. Its relative importance and frequency undoubtedly vary greatly with type of organism. In the so-called lower mammals it may be the principal mode of adaptation, whereas in the primates, and particularly in the anthropoid apes, it may yield first place to learning with insight.

We would again invite attention to the fact that many natural and experimental methods of studying behavioral modifications are of such nature that perception of essential relations, insight into the solution of the problem presented, or, in the human sense, understanding of the necessary means to solution, is either impossible or highly improbable. After the problem has once been solved, the situation often is so far altered that insight becomes possible; but even in such cases, conditions are often extremely unfavorable to its appearance. We shall illustrate this point by mentioning certain types of method which in various forms have been used in the study of anthropoid apes, as well as other mammals, and which in our opinion frequently are ill suited to reveal ability to learn with insight. Mention of three methodological categories will suffice. They are the problem or puzzle-box method, the maze or indirect-route method, and the method of multiple choices.

Puzzle boxes, which require the manipulation of bolts, latches, locks, hooks, and other devices, present novel, soluble problems. Not infrequently the mechanisms and their relations are perceptually unfamiliar to the subject, and occasionally the arrangement is such that essential features of the situation cannot be seen clearly and completely. Although it is manifestly unreasonable to expect an animal to discover essential relations and act as though it understood a situation under such conditions, investigators have repeatedly committed this methodological error and continue to do so. Köhler has emphasized appropriately the necessity for simple, completely perceivable experimental situations, if insight is to be fairly tested. Probably the puzzle-box method has most frequently been seriously defective in this respect.

The maze method, however, is subject to similar criticism. It often is used in such form or manner that the animal cannot possibly, prior to actual experience in the solution of its problem, namely, following a certain course from starting point to goal, anticipate the nature of that course, the baffling barriers, blind alleys, or other types of difficulty which may beset its way. Adaptation, therefore, must necessarily depend on more or less blind trial and the elimination of mistakes after they have been made, instead of on the initial avoidance of mistakes. It is strange indeed that in so many instances and for so long a time investigators of animal behavior have continued to present problems which are insoluble on the basis of perceptual examination and understanding of relations. Presumably the chief reason is that ability to learn otherwise than by trial has not ordinarily been anticipated.

By a third type of method we shall further illustrate possible sources of error and also of discovery of different modes of adaptation. We have selected the multiple-choice method because it is a procedure which we designed for the express purpose of demonstrating and distinguishing learning by trial

versus insight. The method, as previously described (pp. 184 ff.), gives the subject opportunity to choose from a presented group

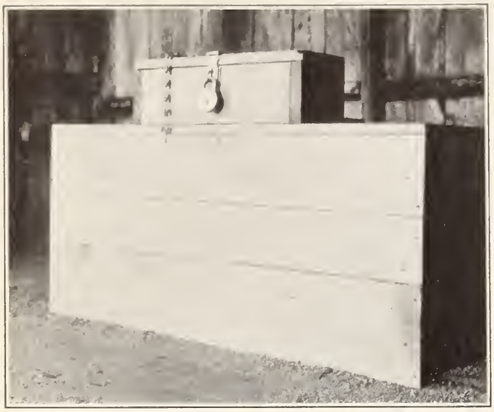


Fig. 108. Food-containing box fastened by a padlock.

of reaction mechanisms that one which when manipulated supplies some type of reward. The correct mechanism for any given problem bears a certain definite spatial relation to the other mechanisms of the group. For example, let us suppose that it is defined as the second mechanism from the left end of the group. Then, in successively confronting the problem the animal either must learn to respond correctly to each of various groups of mechanisms in different spatial relation to the total apparatus, or it may instead learn to respond to the spatial relationship in the group which we describe as second from left end. The former method of learning obviously involves trial and the gradual elimination of errors, whereas the latter, as illustrated in the performance of a young orang-outan (pp. 185-187), may occur suddenly as result of discovery of the essential relationship. This variety of adaptation may involve insight or understanding.

We have used the multiple-choice method in the study of chimpanzees. Our unpublished results indicate that they initially work by a process of trial. The number of mistakes gradually diminishes, but even in hundreds of trials there may not appear indication of discovery of the relationship, or, in other words, of insight. Thus it would seem from our initial results, for this work is unfinished, that the method may reveal either or both types of adaptation, in accordance with the nature of the subject.

Without further illustration we would state from analysis of pertinent observations in the literature, and from our own unpublished data, that the chimpanzee commonly exhibits trial and error as adaptational method. Many problems are solved, or, better, many adaptations are achieved, solely on the basis of this procedure. But there are times when blind trial gradually gives place to insight and in the end the solution seems to involve thorough perceptual grasp of the essential features of the problematic situation and a measure of insight which, had it originally appeared, would have obviated mistakes. Our experience indicates that it is difficult to predict whether a given method will evoke blind trial or insight. Conditions may be unfavorable for the one or the other, and a situation may initially or in the course of re-presentations evoke both types of adaptation.

Fig. 109. A chimpanzee in the act of using key to open lock. Unpublished observations of R. M. Yerkes.

Almost the entire experimental literature on intelligence in the chimpanzee is directed toward definite knowledge of the nature of

the learning process and demonstration of the ability or inability of these apes to learn with insight. Scores of different methods have been employed. To give an adequate account of our own experiments and those of Köhler would require a volume. It therefore is necessary to select typical experiments and by describing them and their results to indicate the characteristics of adaptive response and the evidences which have led most observers to conclude that the chimpanzee is capable of four at least of the five modes of adaptation which were previously mentioned (p. 344); namely, repetitional modification, trial and error, observational elimination and selection, insight and direct adaptation. Whether or not pre-adaptive response based on foresight, and involving in varying degrees abstraction and generalization, occurs, most investigators are still in doubt. Without further anticipatory comment we would briefly describe several types of experiment which have yielded extraordinarily interesting, illuminating, and surprising results.

In the following experiments, which are chosen as typical of the procedures used in the study of habit formation in the chimpanzee, there appears great variety, but they have in common the definite presentation of a visible objective which can readily be attained by suitable activity on the part of the subject. In what has been called a roundabout-course problem, Köhler presented opportunity for simple adaptation by placing between the subject and its goal a barrier which cut off the direct route. The goal, however, was visible and could readily be reached by following an indirect route. Whereas the hen has great difficulty in solving this simple problem, the dog may react appropriately almost at once, and so also does the chimpanzee. Köhler thus characterizes the successful response:

> If the experiment has not been made often, there is the additional fact that the moment in which a true solution is struck is generally sharply marked in the behaviour of the animal (or the child) by a kind of jerk: the dog stops, then suddenly turns completely round (180°), etc., the child looks about, suddenly its face lights up, and so forth. Thus the characteristic smoothness of the true solution is made more striking by a new start when it is begun. (1925, p. 17.)

It thus appears that in the opinion of Köhler solution with insight is observably different from trial and error.

Somewhat more difficult perhaps than the ordinary roundabout-course problem is the following. A basket containing visible food is suspended from the ceiling in such wise that it can be reached by the animal only from one point and then only as the basket swings within reach from that point. Imagine the chimpanzee in the experimental setting and the basket set swinging by the experimenter. We relate the results for a single animal in Köhler's words.

> Sultan, who was not present at these experiments, was tested with the same swing, but this time, before he saw it, the basket was set swinging in a circle which brought it at regular speed past a beam; the circular swing and the regular speed doubtless made this experiment a little harder. Sultan looks up for a second, and follows the basket with his eyes; when he sees it swinging past the beam, he is up there at once, awaiting it.
>
> In experiments such as these, it does not matter at all whether the point which the swing approaches remains the same in successive experiments or not; and neither does it matter whether the vantage-point is a wall, a tree, a scaffolding, or anything else. If variations of this sort are introduced, the same animal does not climb up to the spot at which it was successful before; it clambers with complete certainty to the right place for that situation. In experiments as simple as this, I never saw this rule broken, but in harder tasks, mistakes involving stupid repetitions did occur. (1925, p. 20.)

Still more difficult is the problem of a roundabout course if a considerable part of the route which must be followed is invisible. An illustration is a case in which Köhler, with a chimpanzee subject watching, threw a banana from a window in the apehouse. Again we report the behavior of Sultan.

> I take Sultan with me from another room of the monkey-house, where he was playing with the others, lead him across the corridor into that room, lean the door to behind us, go with him to the window, open the wooden shutter a little, throw a banana out, so that Sultan can see it disappear through the window, but, on account of its height,

Fig. 110. A chimpanzee using boxes and stick as instruments. From W. Köhler, 1921, by courtesy of J. Springer, publisher.

does not see it fall, and then quickly close the shutter again (Sultan can only have seen a little of the wire-roof outside). When I turn round Sultan is already on the way, pushes the door open, vanishes down the corridor, and is then to be heard at the second door, and immediately after in front of the window. I find him outside, eagerly searching underneath the window; the banana had happened to fall into the dark crack between two boxes. Thus not to be able to see the place where the objective is, and the greater part of the possible indirect way to it, does not seem to hinder a solution; if the lay of the land be known beforehand, the indirect circuit through it can be apprehended with ease. (1925, pp. 20-21.)

In the solution of problems of this sort the dog probably is quite as apt as the chimpanzee.

Essentially different in several respects from the types of problem which we have mentioned are those which demand the tracing of an indirect route with a stick used as implement. Picture a situation which Köhler has thus described and note the characteristics of the subject's efforts at adaptation. The experiment was performed, says Köhler, on the quietest and most sensible animal, Nueva.

She sits behind a railing, outside which, forty-five centimetres away, is a contrivance in the form of a square drawer (open on top), from which one side is missing. The edges are thirty-eight centimetres long, the three vertical sides six centimetres high; this "roundabout-way-board" is placed on otherwise free ground, in such a way that the side *without* a vertical wall is turned away from the animal (hereinafter called the normal position). The experimenter places the objective (banana) at point O, and then gives Nueva a longish stick. The animal scratches the objective towards her (0°), but soon cannot get it any farther because the front side of the drawer is in the way. She becomes very distressed, complains, and pleads, but no help is forthcoming. At last she seizes the stick again and tries once more to pull the objective towards her at 0° (i.e. in a straight line). Suddenly she changes her tactics; *instead* of putting the stick *behind* the objective and pulling, she puts it *in front* and *pushes* it with little jabs, but with all assurance towards the open side (that is, in the direction of about 180°). She keeps up this careful and regular shoving until near the edge of the board, where, without any jerk or unsteadiness in the conduct of the animal, the stick happens to be brought *behind* the objective, which is pulled back several centimetres (about five). The "change" only lasts a few moments and then she starts pushing quite obviously towards the opening again; the objective is quietly pushed along sideways from the drawer with even movements and finally brought to port in a curve (on the left side).

On repeating this performance a few minutes later, the whole detour, with a clear beginning at 180°, is again accomplished without any mistake. (1925, pp. 239-240.)

Similar results have been reported by Yerkes (1928, p. 21).

The chimpanzee naturally and eagerly uses straws, wires, bits of cloth, sticks, and other small objects in drawing to it things which are beyond the reach of its arm. Köhler characterizes the stick as a universal instrument for this ape. Strings, ropes, sticks, and other simple objects, may be used to advantage in setting problems. A considerable variety of tests of intelligence involving the use of objects by the apes and other mammals was suggested several years ago by Hobhouse (1901, p. 152 ff.), who on zoölogical-garden subjects made a few critical observations. Both Köhler and Yerkes make acknowledgment to Hobhouse, especially for his methodological suggestions.

Whether all chimpanzees learn of their own initiative to use sticks and other objects as tools is uncertain, but it has been definitely proved that many individuals readily learn to solve certain problems by using implements. Seldom, if ever, has imitative influence been definitely excluded, for in no case has the previous history of a subject been so thoroughly known that the influence of human activity can be denied. Especially impressive in its use of the stick is the versatility of the chimpanzee.

Although in all probability objects sometimes, and perhaps frequently, are used by these animals without tuition, no experiments on record fully justify this conclusion. Hence, evidences from use of objects as tools are less satisfactory indications of intelligent adaptation than are certain variations and special adaptations in connection with use, such as the following.

We borrow from Köhler this account of an experiment in which one of his subjects

obtained a serviceable instrument for its immediate need by breaking a branch from a small tree.

Tschego had used sticks as implements during the preceding days and even on the morning before the experiment to be described. A tree is placed about two metres away from the bars, and Tschego is then let into the room. She does not see the tree at first, but when her eye lights on the objective, goes as usual into her bed-room, fetches her blanket, stuffs it through the bars, throws it on to the objective, and tries thus to draw it towards her. For the blanket can be used in two ways, either of which might succeed: beating the goal towards her, or pulling it towards her, after the cover has been thrown over it. The cover is taken away from her; she seizes the tree and makes a great effort to squeeze it, just as it is, through the bars. When that does not succeed, she takes a bundle of straw in her hand, stretches out with it like a stick, and endeavours to pull the objective towards her. As the bundle proves to be too soft, and does not drag the objective with it when pulled along, she takes hold of the straw in the middle with her teeth, and at one end with her hand, and bends one half over the other, so that a bundle half as long, but incomparably firmer, a real sort of stick, is formed; this she uses at once, and, while it remains long enough, again and again, with complete success. The whole proceeding, from the taking of the bundle of straw which is too soft, up to the use of the firmer one, is one cohering action; it lasts but a few seconds. In this way a method of making implements has been invented that is different from the one expected; Tschego did not, at any time, show any indication of breaking off a branch of the tree, but she clearly showed that she "had present" the *use of the stick* all through the experiment. The tree, by the way, was only a very small one, which Tschego could easily manage as a whole. This explains why she wanted to use this whole as a stick; but the rough procedure by which she pushes it towards the bars, as if she could thus get it through, is, of course, not justified by the size of the little tree.

The next day the test is repeated; the little tree lies in exactly the same place as on the day before at the beginning. Tschego uses a bundle of straw as a substitute for the stick, and, when it proves too soft, folds it double just as in the first test, making it also stiffer. This time, even after folding it, it still remains too flexible, so she hastily repeats the proceeding, and the bundle, now composed of four folds, thus becomes extremely firm. But now it is too short, and Tschego tries to squeeze the whole tree through the bars. As, of course, she fails in this also, she returns to the straw, and, after many failures, finally sits down quietly. But her eyes wander and soon fix on the little tree, which she had left lying a little way back. All of a sudden, she seizes it quickly and surely, breaks off a branch, and immediately pulls the objective to her with it. This proceeding has no relation to her former attempts to push the tree through the bars. While breaking off the branch, Tschego turns one side towards the bars; the little tree does not touch them at all and is neither treated as a whole nor moved towards the bars; nothing else is involved but just the *breaking off of the branch*.

In this experiment, what is particularly worth noting is the fact that, for a long time, not the slightest sign was given of the expected solution; when the branch is suddenly broken off, the proceeding goes on, without any "hiatus," to the reaching out with the stick thus created: *both actions together make one united proceeding*. (1925, pp. 110-112.)

This appears to be an approach to the discovery and in a sense also to the making of a tool, and it suggests a type of adaptation which has ordinarily been assumed to occur only in man. Additional evidence of the chimpanzee's ability to construct tools is afforded by the following single observation, which we may not more satisfactorily describe than in the words of Köhler.

Are the two sticks ever combined so as to become technically useful? This time Sultan is the subject of experiment. His sticks are two hollow, but firm, bamboo rods, such as the animals often use for pulling along fruit. The one is so much smaller than the other, that it can be pushed in at either end quite easily. Beyond the bars lies the objective, just so far away that the animal cannot reach it with either rod. They are about the same length. Nevertheless, he takes great pains to try to reach it with one stick or the other, even pushing his right shoulder through the bars. When everything proves futile, Sultan commits a "bad error," or, more clearly, a great stupidity, such as he made sometimes on other occasions. He pulls a box from the back of the room towards the bars; true, he pushes it away again at once as it is useless, or rather, actually in the way. Immediately afterwards, he does something which, although practically useless, must be counted among the "good errors": he pushes one of the sticks out as far as it will go, then takes the second, and with it pokes the first one cautiously towards the objective, pushing it carefully from the nearer end and thus slowly urging it towards the fruit. This does not always succeed, but if he has got pretty close in this way, he takes even greater precaution; he pushes very gently, watches the movements of the stick that is lying on the ground, and actually touches the objective with its tip. Thus, all of a sudden, for the first time, the contact "animal-

objective" has been established, and Sultan visibly feels (we humans can sympathize) a certain satisfaction in having even so much power over the fruit that he can touch and slightly move it by pushing the stick. The proceeding is repeated; when the animal has pushed the stick on the ground so far out that he cannot possibly get it back by himself, it is given back to him. But although, in trying to steer it cautiously, he puts the stick in his hand exactly to the cut (i.e. the opening) of the stick on the ground, and although one might think that doing so would suggest the possibility of pushing one stick into the other, there is no indication whatever of such a practically valuable solution. Finally, the observer gives the animal some help by putting one finger into the opening of one stick under the animal's nose (without pointing to the other stick at all). This has no effect; Sultan, as before, pushes one stick with the other towards the objective, and as this pseudo-solution does not satisfy him any longer, he abandons his efforts altogether, and does not even pick up the sticks when they are both again thrown through the bars to him. The experiment has lasted over an hour, and is stopped for the present, as it seems hopeless, carried out like this. As we intend to take it up again after a while, Sultan is left in possession of his sticks; the keeper is left there to watch him.

Fig. 111. The chimpanzee "Sultan" constructing a serviceable instrument by joining two sticks. From W. Köhler, 1921, by courtesy of J. Springer, publisher.

Keeper's report: "Sultan first of all squats indifferently on the box, which has been left standing a little back from the railings; then he gets up, picks up the two sticks, sits down again on the box and plays carelessly with them. While doing this, it happens that he finds himself holding one rod in either hand in such a way that they lie in a straight line; he pushes the thinner one a little way into the opening of the thicker, jumps up and is already on the run towards the railings, to which he has up to now half turned his back, and begins to draw a banana towards him with the double stick. I call the master: meanwhile, one of the animal's rods has fallen out of the other, as he has pushed one of them only a little way into the other; whereupon he connects them again."

The keeper's report covers a period of scarcely five minutes, which had elapsed since stopping the experiment. Called by the man, I continued observation myself: Sultan is squatting at the bars, holding out one stick, and, at its end, a second bigger one, which is on the point of falling off. It does fall. Sultan pulls it to him and forthwith, with the greatest assurance, pushes the thinner one in again, so that it is firmly wedged, and fetches a fruit with the lengthened implement. But the bigger tube selected is a little too big, and so it slips from the end of the thinner one several times; each time Sultan rejoins the tubes immediately by holding the bigger one towards himself in the left and the thinner one in his right hand and a little backwards, and then sliding one into the other. The proceeding seems to please him immensely; he is very lively, pulls all the fruit, one after the other, towards the railings, without taking time to eat it, and when I disconnect the double-stick he puts it together again at once, and draws any distant objects whatever to the bars.

The next day the test is repeated; Sultan begins with the proceeding which is in practice useless, but after he has pushed one of the tubes forward with the other for a few seconds, he again takes up both, quickly puts one into the other, and attains his objective with the double stick. (1925, pp. 130-133.)

If this particular type of solution should be exhibited under rigidly controlled experimental conditions by several specimens of chimpanzee, few psychobiological observers would be likely to deny insight or to hesitate in describing the behavior as highly intelligent.

Sultan's tool-making ability is exhibited in yet another and significantly different problematic situation of which Köhler tells us.

In another experiment, further manufacture of implements is demanded of Sultan. Besides a tube

with a large opening, he has at his disposal a narrow wooden board, just too broad to fit into the opening. Sultan takes the board and tries to put it into the tube. This is not a mistake; the different *shapes* of the board and the tube would tempt even a human being to try it, because the difference in thickness of both these objects is not obvious at first sight. When he is not successful, he bites the end of the tube and breaks off a long splinter from its side, obviously because the side of the tube was in the way of the wood ("good error"). But as soon as he has his splinter, he tries to introduce it into the still intact end of the tube; a surprising turn, which should lead to the solution, were not the splinter a little too big. Sultan seizes the board once more, but now works at it with his teeth, and correctly too, from both edges at one end towards the middle, so that the board becomes narrower. When he has chewed off some of the (very hard) wood, he tests whether the board now fits into the sound opening of the tube, and continues working thus (here one must speak of real "work") until the wood goes about two centimetres deep into the tube. Now he wishes to fetch the objective with his implement, but two centimetres is not deep enough, and the tube falls off the top of the wood over and over again. By this time Sultan is plainly tired of biting at the wood; he prefers to sharpen the wooden splinter at one end and actually succeeds so far as to get it to stick firmly in the sound end of the tube, thus making the double stick ready for use. In connexion with this treatment of the wood it must be remarked that, contrary to my expectation, Sultan bit away wood almost exclusively from *one* end of the board, and, even if he took the other end between his teeth for a moment, he never gnawed blindly first at one, and then at the other. His way of dealing with the tube was also very satisfactory. The one opening of the tube that had been spoiled by breaking its side is thereafter left unheeded. I had some anxiety for the other opening during the further experiment, but although Sultan, when the wood and splinter did not fit in, put his teeth into it several times, he never really bit into the side of the tube, so that the opening could still be used. I could not guarantee that each repetition of the experiment would turn out so well. Sultan evidently had a specially bright day. (1925, pp. 136-138.)

Köhler's observations on the manipulation of environment in a fashion which he calls the making of implements are important. Except for incidental and entirely uncontrolled observations, they stand alone in the literature. It is natural that the results reported should be questioned until verified by other observers. From our own experience we are led to believe that unusually gifted chimpanzees are likely to exhibit precisely such adaptations as Köhler describes. As it happens, we have not attempted to repeat his experiments, nor have we obtained in connection with other lines of inquiry evidence which definitely confirms or supplements his statements. It is manifestly desirable that a competent investigator systematically study the implement-making ability of the chimpanzee.

A convenient form of problem used by various investigators in observing initiative and methods of adaptation in the chimpanzee is called box stacking (see Bingham, 1929, for standardized method). The situation is arranged by suspending desired food in such wise that it may be obtained by the animal only by seeking and properly placing one or more boxes. Naturally the use of a single box is easier than the use of two or more, for in the latter case construction in addition to appropriate placement is essential. Repeatedly it has been demonstrated that the chimpanzee will readily and apparently spontaneously use a single box for the solution of this type of problem. The use of two boxes is exhibited by certain individuals. We have already had occasion to describe the initial failure of a young orang-outan in this problem (pp. 188-190) and we would now offer by contrast the success of certain chimpanzees.

Thus Köhler relates that:

In one of the experiments described previously, Sultan came very near putting one box on top of another, when he found the one insufficient; but instead of placing the second box, which he had already lifted, upon the first, he made uncertain movements with it in the air around and above the other; then other methods replaced these confused movements. The test is repeated; the objective is placed very high up, the two boxes are not very far away from each other and about four metres away from the objective; all other means of reaching it have been taken away. Sultan drags the bigger of the two boxes towards the objective, puts it just underneath, gets up on it, and looking upwards, makes ready to jump, but does not jump; gets down, seizes the other box, and, pulling it behind him, gallops about the room, making his usual noise, kicking against the walls and showing his uneasiness in every other possible way. He cer-

Fig. 112. A group of chimpanzees working together. From W. Köhler, 1921, by courtesy of J. Springer, publisher.

tainly did not seize the second box to put it on the first; it merely helps him to give vent to his temper. But all of a sudden his behaviour changes completely; he stops making a noise, pulls his box from quite a distance right up to the other one, and stands it upright on it. He mounts the somewhat shaky construction, several times gets ready to jump, but again does not jump; the objective is still too high for this bad jumper. But he has achieved his task.

Chica and Grande learnt, some days previously, from Sultan and myself, how to use *one* box; they do not yet know how to work with *two*. The situation is the same as in Sultan's experiment. Each of the animals forthwith seizes a box; first Chica, then Grande, will stand under the objective with their box, but there is no sign of an attempt to put one on top of the other. On the other hand, they hardly get up on their own box; though their foot is lifted, they put it down again as soon as their glance is turned upwards. It is certainly not a matter of accident, but the result of that upward glance at the objective, when both Chica and Grande proceed to stand the box upright; a measurement of the distance with the eye leads to this change of plan; it is a sudden and obvious attempt to meet the needs of the situation. Finally, Grande seizes her box and tears about the room with it, in a rage, as Sultan did before. Just as with him, she calms down unexpectedly, pulls her box close to the other one, after a glance at the objective, lifts it with an effort, puts it clumsily on the lower one, and quickly tries to get up on it; but when the upper box slips to the side during this operation, she makes no move, and lets it fall altogether, quite discouraged. In principle Grande solved the problem too, so the box is lifted by the observer, placed firmly on the lower one, and held there, while Grande climbs up and reaches the objective. But she does all this with the greatest mistrust. (1925, pp. 139-141.)

For one of our own subjects, a gifted young male chimpanzee, the following somewhat more explicit description of method and behavior is available. We quote it at length because it is impossible to evaluate

the solution of a problem without full knowledge of the characteristics of the situation and of the animal's varying relations to it.

The setting of the box stacking experiment may be briefly described as follows: A light strong cord was attached to the ceiling of a room approximately 8 feet high. The nearest point from which the animal could reach toward this cord was more than 5 feet distant. To the cord a banana was attached at distances from the floor ranging from approximately 150 to 200 cm. Three boxes were provided for the animal's possible use, each with one open side. The boxes differed in size in accordance with the following dimensions: no. 1, 16 by 12 by 11 inches (one 16 by 12 side open); no. 2, 16 by 10 by 9 inches (one 16 by 10 side open); no. 3, 11 by 11 by 10 inches (one 11 by 11 side open). These boxes were placed on the floor of the room within convenient reach of the string, but so far from it that the animal could neither reach from them nor spring from them to the reward without moving them.

As it was ascertained in advance that Chim could by springing reach an object approximately 100 cm. from the floor, the banana in the first instances was placed 150 cm. from the floor.

In this test the initial use of a box to reach or spring from came slowly. Chim exhausted all other possibilities of approaching the reward before finally attempting to move one of the boxes. Having tried this experiment and discovered that it worked he very naturally came to drag the boxes about and place them to suit his purpose. Then came a period of resourcelessness when the banana was placed at such a height from the floor that it could not be obtained by the use of any single box. Under these conditions Chim wasted one full period (usually about thirty minutes) of observation.

The utilization of two or more boxes appeared suddenly and without warning as described below.

At 6.30 P.M. on August 27 and before the evening meal, the box stacking test was arranged. Chim was in fine working condition. The string was baited with a large banana placed about 150 cm. from the floor. The three boxes were placed about the room at least 2 feet from a point directly beneath the banana.

Chim made no move to get the banana until I left the room. Then he turned to his task directly and with extreme energy and evident determination.

First he sprang a few times from box 1 in its original position, but it was too far away for him even to touch the banana. Promptly abandoning this method he seized box 3 and moved it toward the center, leaving it perhaps 12 inches off center. From this box, thus placed, he jumped in rapid succession twenty or more times, working with utmost persistency and energy. Stopping he turned suddenly toward the rear side of the room and pulled a blanket from peg to floor. I supposed he was going to use it in some way, but instead he immediately dropped it, left it lying on the floor, and returned to box 3 from which he jumped two or three times.

Then, with no hesitation, he seized box 3, carried it directly to box 2 and placed it thereon with its open side uppermost. He now tried to stand on the edge of box 3, but as this proved an unstable point from which to spring, he immediately abandoned it, having made only one or two futile efforts to spring from the stacked boxes. He next pulled box 3 from box 2, carried it to box 1 and placed it thereon insecurely. Immediately he mounted the boxes and skilfully balancing on box 3 as it rested on box 1, he jumped toward the banana. At the same time box 3 fell to the floor, but Chim seized the banana as he sped through the air and eagerly devoured his reward.

This whole performance required less time than it takes to describe it because he worked with great rapidity, jumping so hard and repeatedly that at times I was afraid he might injure himself. The total time from setting of experiment to success was less than five minutes.

Thus with surprising suddenness appeared the perfect solution of the box stacking test. Subsequent opportunities to meet the situation adequately resulted merely in the perfecting of method. It is needless to describe the process. Chim had gained the necessary insight for the solution of the problem. That insight came not by suggestion from the experimenter, as in the case of Julius, the young orang-utan, but through observation, apparently supplemented by reflection. (Yerkes and Learned, 1925, pp. 45-47.)

It was in connection with suspended food problems that Köhler observed the following amusing and also psychologically significant behavior of one of his animals. It became very angry, he says, when the keeper, whom it had led to a position under a suspended banana, stooped over so that from his shoulder it could not reach the coveted prize. In addition to an emotional disturbance, the animal exhibited behavior of a peculiarly interesting type in that it tried to push the man into an upright position (Köhler, 1925, p. 146). In similar fashion, as indicated in the descriptions of Köhler and Yerkes, boxes or other objects, which are habitually used to stand on or to climb with, may be held up toward the suspended food.

It would be easy indeed to multiply types of problem and descriptions of response to them, but instead of extending this chapter

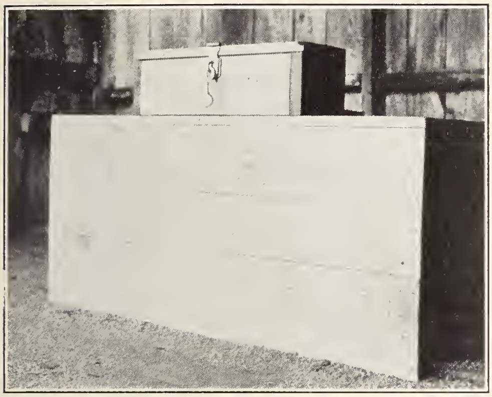


Fig. 113. Food-containing box fastened by a harness-snap.

unduly we would recommend the critical reading of Köhler's study of chimpanzee intelligence, either in the original German or in English or French translation. Our own results, which in many directions supplement, although in general they also confirm, those of Köhler, are unpublished except for such references as are presented in this volume.

INSTRUMENTATION

Because of the profound importance in human life of adaptation of environment versus self-adaptation, we here recur to those aspects of the adaptive life of the chimpanzee which belong in this category and which have been referred to as the manipulation of environment, the use of objects as tools, and the making of tools. Evidently all such behavior may be considered an approach to control of conditions of life. Previously, in various connections, we have described specific experiments which to greater or less extent demanded, and as well exhibited, adaptation by modification of environment. We would now briefly and systematically consider the total body of information and its psychobiological significance.

For the wild chimpanzee the use of objects has seldom been precisely and convincingly described, doubtless because of the difficulties of observation. Nest-making, however, is well known by its final result rather than by description of the process. The throwing of objects has been observed, and also the occasional use of sticks. One naturally infers from the literature that in nature this anthropoid ape does not to any considerable extent utilize environmental objects as instruments. Possibly the inference is incorrect, for it must be granted that information is both meager and of uncertain value.

In captivity, and especially when observed under experimental conditions, the animal is known to exhibit numerous and varied efforts to shape environmental situations to meet its requirements. To what extent this is due to human association and imitative tendency has not been determined, and it is not unreasonable to suggest that many supposed evidences of intelligent adaptation with insight or foresight and of creative imagination or abstraction and generalization are but reproductions or reflections in the behavior of the ape of human traits and capacities. But if we take

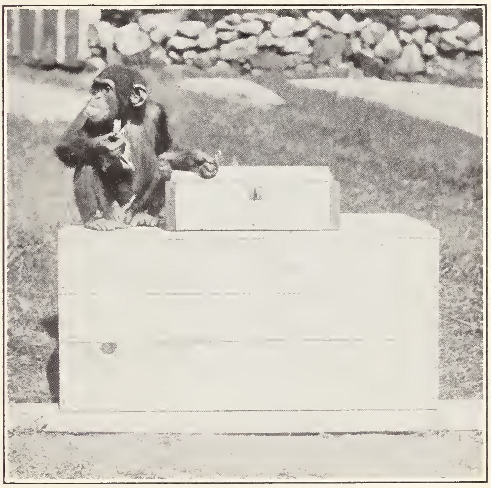


Fig. 114. Success in opening the box. Unpublished observations of R. M. Yerkes.

such a suggestion seriously we must consider also the fact that despite prolonged association with man, this ape does not to

any considerable extent utilize human signs or symbols and particularly fails to imitate human speech.

Elsewhere we have suggested that there is strong tendency to imitate what is seen, slight tendency to imitate what is heard. Marbe (1916-17) has suggested the possibility of telepathy as between ape and man. The significance of these suggestions and facts, although difficult to determine, is such that critical experimental inquiry should be instituted. Otherwise we may presently discover that we have been seriously misled and have attributed to the original adaptive capacity what is primarily due to human influence.

Varieties of tendency to alter, modify, or use environment, more or less frequently exhibited by the chimpanzee, are enumerated below in six categories. We make no claim for completeness, but instead present this logical arrangement of materials to exemplify the major varieties of observational data.

(1) Construction of shelters or resting places. The chimpanzee on occasion builds crude shelters from sun, rain, and wind. There is also the more elaborate nest which is used as resting place for the night. Whether the process of construction is primarily instinctive, imitative, or individually adaptive, is not known. Therefore, it is entirely impossible to evaluate shelter construction as form of behavioral adaptation.

(2) Use of objects as weapons. Stones, sticks, and branches may be used in defense or aggression. That this often occurs is not established by reports; that it is characteristic of the chimpanzee as type instead of as individual also is uncertain. Nevertheless, the facts entirely justify the mention of use of objects as weapons as a category worthy of systematic investigative attention.

(3) Manipulation of objects in proximity to food. This phrase is descriptive of the tendency of the ape to give attention to and in various ways move objects which either are continuous with visible food, in close proximity to it, or appear as obstacles between it and the animal. Herein the natural conditions of life doubtless figure importantly, for the food supply is ordinarily on tree, bush, or low growing plant, and from the early months of life onward the individual learns to obtain nourishment by certain simple manipulation of food bearers. Under experimental conditions it has been proved that gifted specimens may ingeniously and with seeming insight or foresight arrange and manipulate wires, strings, ropes, sticks, and other objects, in such manner as to facilitate the attainment of an objective. Similarly, obstacles or barriers in the animal's path may be removed with seeming definiteness of intent.

(4) The utilization of objects as aids in climbing. This is a matter of common report in nature and in captivity. Indeed, it appears to be characteristic of the manlike apes to attempt to utilize free objects to facilitate their bodily movements. The stick or pole may, for example, be grasped and used to climb upon or leap from in the animal's attempt to reach some overhead object. Similarly, in experiments, tables, boxes, or, indeed, almost any object may be used. Considerable ingenuity is displayed by certain chimpanzees in this sort of environmental manipulation.

(5) Extension of reach by use of an object. Although intimately related to the previous category, this seemingly deserves separate description because of certain characteristic differences. The animal may grasp a stick, wire, straw, or other movable object and thrust it toward desired food, thus achieving in effect physical extension. Several subdivisions of such activities are indicated; we shall mention four: (a) Reaching toward food with environmental object; (b) drawing in food with suitable object; (c) pushing or poking food or other desired object through pipe or box so that it may be reached with a hand; and (d) utilizing a stick or other object to direct food in a roundabout course. These categories indicate increasing complexity of manipulative adjustment, and almost certainly if intelligently used they will aid us to differentiate

stages in primate development and the principal classes of existing primate.

(6) Construction of implements. The last is also the most important of our categories, for it implies an order of adaptive ability which few investigators would expect to discover in infrahuman organisms. Nevertheless, it is well established that the chimpanzee occasionally at least makes instruments for the satisfaction of its needs. In view of our previous descriptive statements it will here suffice to list a few typical instances. There are, for example, numerous convincing accounts of the construction of box pyramids; there are Köhler's instances of the breaking of a branch from the tree that it may be used as a stick, of the tearing of a splinter from a board to be similarly used, of the joining or splicing of sticks that one of sufficient length may be made available, and of the chewing of one end of a stick in order that it may fit into the aperture of another. Various observers have reported search for an object which will serve as a key and attempts so to alter such objects that they can be inserted into a keyhole. Successes in endeavors of this sort also are on record. Finally, the literature abounds with miscellaneous examples of the utilization of one or another type of object to modify some other object or aspect of the environment. Of this an excellent instance is the use of a stick as a lever to pry off locks and other types of restraining mechanism.

Once more we disclaim effort toward completeness in classification and enumeration of modes of modifying environment. It has been our sole purpose to enumerate tendencies which are clearly indicated in reliable descriptions of chimpanzee behavior, but whose frequency of occurrence and significance in the life of the species is entirely undetermined. We have given conspicuous place throughout this chapter to examples of control of environment through the utilization of objects as tools and otherwise, because of the obvious significance of such behavioral development in primate life. Certainly such tendencies as have been pointed out profoundly influence the conditions of human life, if not also the course of evolution.

We may suitably conclude consideration of this important topic by enumerating our chief sources of information concerning the use of implements. Hermes (1876), Hobhouse (1901), Haggerty (1910, 1913), Rothmann and Teuber (1915), Knauer (1915), Marbe (1916-17), Heck (1922), Köhler (1918, 1925), Yerkes (1925), Yerkes and Learned (1925), Drescher and Trendelenburg (1927), Bingham (1929).

TENTATIVE CONCLUSIONS

On the basis of experimental studies of chimpanzee intelligence we would present tentatively, and with intent to stimulate further inquiry and the thorough testing of our statements, the following conclusions and inferences.

The chimpanzee, at least during its early years, for the experiments reported have been made with individuals between three and eight years of age, exhibits behavior in the solution of more or less novel problems which is strikingly contrasted with that of mammals other than man and the manlike apes in the points enumerated below.

Attention in face of a compelling problem is or frequently may be definitely directed or focused on a situation or, in turn, on essential features of the situation; concentrated, and sustained for periods of several seconds or even minutes with slight visible variations.

The activities of the animal, in face of a problem which it has strong desire to meet successfully, are or may be definite in character and often persistently followed for a considerable time. Frequently the initiation of a definite act or series of acts follows upon systematic survey of the situation and special examination or trial of essential features.

A method of attempted solution of the problem which has proved definitely unsuccessful is or may be suddenly abandoned for another seemingly entirely independent

and wholly different activity. This sometimes indicates discouragement with the situation and again transition to a new type of effort.

Often between activities, and especially when one method is being abandoned for another, there occur definite pauses in which the animal examines the situation or seemingly takes stock of its efforts in relation to its problem. Usually this period of what looks like "consideration" or "reflection" is followed by another vigorous and determined attack on the problem.

At times there appear series of acts the essential parts of which are performed in predetermined relation to the end result of the series. The action pattern appears to be determined by the reward which is in view, and from the outset the animal performs the unit acts as though they were merely elements in a whole which is (as Köhler says) greater than the sum of its parts.

More startling by far than the quick passage from one method to another is the sudden solution of problems. Köhler, Kohts, and Yerkes have described this feature of chimpanzee behavior. Frequently, although of course not in all individuals or in all problems, correct and adequate solution is achieved without warning and almost instantly. It may have been preceded by the trial of ineffective methods or by such trial and periods of quiescence. But, in the end, success is achieved with a suddenness which brings vividly to mind our own adult experiences of insight, and the behavior of the child when it sees through a problem.

If we may take the liberty of speaking for our fellow workers on the basis of their published reports and in the light of our own fairly intimate acquaintance with the chimpanzee, we should say that the evidence for the solution of problems ideationally is now abundant and convincing. The animals' behavior speaks for degrees and kinds of insight or understanding which so illumine the problematic situation as to render it immediately soluble. To be sure, there are gifted and stupid individuals; good and bad working days; natural and unnatural experimental situations. Sharper contrast it would be difficult to imagine than between the relatively blind and seemingly purposeless "trial and error" activity which is described as typical for the cat[1] and various other mammals when faced with novel problems, and the definitely directed and obviously "thoughtful" acts of the chimpanzee.

We thus conclude discussion of modes of behavioral adaptation in the chimpanzee and account of typical methods and results of the experimental study of this subject. That we have ignored minor contributions in favor always of the incomparably important work of Köhler and Kohts demands neither explanation nor apology.

[1] E. L. Thorndike, "Animal Intelligence," *Psychol. Rev. Monograph Supp.*, 1898, II, No. 4.

CHAPTER THIRTY

INTELLIGENCE OF CHIMPANZEE: IMAGINAL PROCESSES

IN human experience two principal varieties of imaginal experience and behavior are distinguished: the reproductive and the creative. The former is commonly called memory, the latter, imagination. To what extent and in what manner are these types of process indicated by the behavior of the chimpanzee? In reviewing the facts which the pertinent literature supplies we shall not endeavor to distinguish sharply between phenomena of experience and those of behavior, but instead shall assume that each is implied when such expressions as imaginal processes, memory and imagination, are used. We shall consider first materials of memory.

MEMORY

IN considerable abundance there appear in chimpanzee behavior evidences of memory of persons and of aspects of experimental situations. The early literature which contains incidental observations and brief statements concerning memory may be sampled, and the more recent work, especially that which is experimental, more thoroughly and critically examined and evaluated.

To begin with memory of persons, Warwick (1832, p. 307) refers to recognition of a person after short absences from the animal, and, in the same article, to evidence of memory for time or something in the nature of a time sense. Likewise, Rennie (1838, p. 59) mentions memory of a surgical operation which the subject evidently associated with human attendants. As quoted on an earlier page (p. 250), Garner (1896, p. 111) cites memory of a boy who was irritating. Memory for a person over a period of fourteen days is to be found in Sokolowsky (1908, p. 59), and Rothmann and Teuber (1915, p. 10) inform us that persons with whom the chimpanzee is familiar may be remembered over considerable intervals. It is in Furness (1916, p. 286), in a passage which we have already cited on page 327, that we find recorded the longest temporal memory span for a person. It is a case, if we may assume the entire trustworthiness and critical nature of the report, in which a chimpanzee very definitely and obviously recognized after separation of four years, a person who had cared for it during a severe attack of pneumonia. One might reasonably question the accuracy of this report or of the interpretation of the animal's behavior as mnemonic, were it not for such similar and confirmatory evidences as will be presented in the following pages.

Among relatively recent observations on memory of persons by chimpanzees are the following. Heck (1922, p. 672) refers to the remarkable memory of a certain captive chimpanzee for men and animals to which it had become attached. Memory of a person for over a year is asserted and of a bear playmate after several months. Recognition of its master and familiar greeting after separation of as much as five weeks is reported by Sheak (1923, p. 51; 1924, p. 122). "The time in which a chimpanzee lives," says Köhler (1925, p. 287), "would reach very far back toward the *past,* if one were to apply as a sufficient criterion simply the plain after-effects of past experience in present actions. Perhaps none will be surprised to hear that the animals knew me again at once, after a separation of six months (just as Sultan, after being away from the other animals and not having seen them for four months, was immediately upon his return hailed as comrade)." And from our own experience we quote the following:

> We have obtained convincing evidences of memory of persons, over a period as long as one

year. In one instance a pronounced antagonism which Billy acquired for an altogether friendly man, appeared ten months later as specific response to the particular individual. And again, after a like period during which the two had not met, the chimpanzee showed his antagonism by trying to strike and bite the object of his dislike. We might multiply observations indicative of a memory span of many months for objects and events of vivid interest. (R. M. and D. N. Yerkes, 1928, p. 264.)

The evidence is entirely convincing that the chimpanzee may recognize and appropriately respond to a familiar person after a separation of many months. It is further indicated that the period may extend to several years. The recognitional response is so definite and distinctive that from published records and from our own confirmatory experience, we state with assurance that misinterpretation is unlikely, and the results as presented in general trustworthy.

Experimental procedures for the discovery and examination of memory processes vary from attempts to measure the temporal span, to efforts to discover the nature and relations of the essential processes. We shall first consider evidences from the buried-food method. This simple procedure has been used by Köhler and also by us. Köhler, it happens, took no precautions to prevent the functioning of odor in the location of the food. His procedure consisted in allowing a chimpanzee subject to watch him bury some fruit in a certain place and after the lapse of an interval of time, giving the subject opportunity to exhibit memory of the presence and location of the food. It was discovered by him that after intervals as long as sixteen and one-half hours the chimpanzee remembered the food and usually succeeded in locating it promptly and in obtaining it (1925, pp. 290-292). It does not appear from the account of his experiments that sixteen and one-half hours is necessarily the limit of memory, and, as has been suggested, it is possible that odor or other extraneous cues may have assisted the animal. With Köhler, however, we grant the improbability of extraneous cues.

Our own experiments (R. M. and D. N. Yerkes, 1928, pp. 264 ff.), made subsequently to those of Köhler, were conducted somewhat more systematically and with additional precautions and controls. Thus, the food was secretly removed from the spot shortly after the animal had seen it buried, and just prior to the hour for test of memory it was replaced in a sealed jar which obviated the influence of odor. Beginning with a delay of ninety-six hours we tested four animals. For that interval the results were almost wholly negative. With a delay of seventy-two hours certain signs of memory appeared, and with a delay of forty-eight hours each of four animals gave evidence of memory of the food and two promptly located and obtained it. It therefore is established that after an interval of at least forty-eight hours buried food may be remembered and definitely located by the chimpanzee.

The buried-food experiment is crude and in many ways unsatisfactory. We are not convinced that any of the observations reported indicate limits or reveal essential characteristics of the mnemonic process. Contrasting favorably with this procedure and its results are evidences of memory supplied by Köhler from certain of his studies in visual perception.

After conducting a series of observations on absolute versus structure-function response to pairs of colors (described on pp. 330-331) Köhler decided to retest a subject, which had been perfectly trained to discriminate between color stimuli, after an interval of several months during which it had no experience in the experimental situation. He states that from the end of December, 1915, Tercera was given a vacation in that neither blue-red nor other colors were used as basis for choice. The experiment was resumed in February, 1917, after an interval of about thirteen months. When given opportunity to choose between two color stimuli on which she had previously been trained, she made only one mistake in the first ten trials. Köhler remarks: "This result agreed entirely with similar tests of memory which I have made with the ani-

mals, and it is not to be doubted that when it continues in health and is not disturbed by other color experiments, the animal may show after three, five, or even more years a very marked 'economy' in relearning." (1918, p. 78.) The outcome of various observations similar to that mentioned above is thus summarily presented in Köhler's book on intelligence:

> Thirteen months after their last experiments in perception of size, Grande, in a first series of ten tests made *one* error (in the seventh test), while Chica chose all correctly.
>
> Likewise thirteen months after her earlier period of learning, Tercera chose between two different reddish-blue colours all but one out of ten, exactly as before.
>
> About eighteen months after the experiments on *Farbenkonstanz,* Sultan made *one* wrong choice out of the first ten tests, Grande no mistakes at all.
>
> Quantitatively, therefore, the animals lost nothing; their choices were merely made at first a little slowly and hesitatingly. Without doubt, the interval could be very considerably increased, and there would still be a strong after-effect.
>
> For these achievements, there was certainly no necessity whatsoever for any image of the past. The old familiar situation appears again immediately in the form of apprehension acquired then, and the same direction of choice behaviour is followed anew. Almost the same thing will happen if the animals henceforth achieve the solution of an intelligence test already found much more quickly than the first time, and show that they have this power even years later. (1925, pp. 287-288.)

A form of experiment designed especially for the study of memory, and commonly known as the method of delayed response, has been used advantageously with the chimpanzee. We report herewith certain observations which may be classified as delayed responses.

In her experiments by the method of matching sample, Kohts required of her subject that he respond by selection of the appropriate object after the sample had been removed from view. She promptly discovered that as the interval of delay was increased, correct matching became more difficult, and that after fifteen or twenty seconds' delay mistakes were more frequent than correct responses. This seemingly would indicate that under the conditions of experimentation memory of the sample object or quality continued to be efficient for not more than fifteen seconds (Kohts, 1923, p. 488; 1928, p. 274).

Certain experiments on zoölogical-garden captives made by Drescher and Trendelenburg, with the express purpose of contrasting intelligent adaptation in these animals with that exhibited by certain types of monkey and also by cats and dogs, gave these authors opportunity to note the nature of delayed response. Their experiments in the main are irrelevant to the present topic, but their principal conclusion is pertinent, for they remark that whereas for the cat out of sight is in effect out of mind, in case of the anthropoid apes, including the chimpanzee, food which has been seen to disappear is for some time remembered, and activity is importantly influenced by the memory process (1927, p. 632).

We have made preliminary study of the nature of memory processes by means of the following delayed response procedure. The chimpanzee is placed in the center of a large room. Equidistant from it and in each corner of the room is a box in which food may be placed. The boxes, in accordance with the requirements of the experiment, may be alike in appearance or they may differ in one or more visual characters. The subject is allowed to see food placed in one of the boxes. After an interval varying from minutes to hours it is released and thus given opportunity to exhibit memory of the location of the food. A variation of the experiment consisted in removing the subject from the situation during the interval of delay and either using it in other experiments or returning it to its companions. In either case distracting activities may be assumed which one might naturally expect to interfere with or perhaps destroy memory of the experience of seeing the food placed in the box.

In a second series of experiments the situation was varied in that the only visual quality on which the animal could depend for choice of the right box was its color. The food boxes were, respectively, white,

black, red, and green. As previously stated, food was placed in one of the boxes and then in the absence of the animal from the experimental situation the several boxes were so interchanged that both the absolute and the relative position of the food container was altered. Thus it became necessary for the animal to remember a certain visual character in order to respond correctly. The results of these experiments contrast so sharply with previous similar studies of other mammals and are so obviously important as indications of memory processes in the chimpanzee, that we quote herewith the summary and conclusions of our preliminary published report.

1. In a form of "delayed response" experiment devised by us which gives opportunity for choice among four food boxes, the chimpanzee has exhibited ability to respond correctly with immediacy and apparent ease after delays of three hours.

2. Because, previously, delayed response studies with mammals have indicated failure of adjustment after at most a few minutes of delay, we at first suspected that we had discovered a peculiarly important and perhaps distinctively primate capacity for adjustment. Further analysis of our results, however, shortly convinced us of error, and we finally exhibited the fact that our subjects were responding to position or location instead of to the appearance of the food-containing box. Furthermore, it became clear that this type of response is wholly natural, readily given, and may appear, as for example in the buried-food experiment, after delay of some days.

3. To eliminate position or location as possible basis of correct response, we modified our experimental conditions so that the color of the food-containing box was the only constant and dependable factor. In these conditions our subjects were at first entirely incapable of adjustment. We summarize in the following paragraphs the principal features of our results.

4. There appeared in delayed response to color, in an otherwise varying situation from which both absolute and relative position were eliminated as basis of choice:

a. Tendency to go, if possible, to the place where food had been placed, irrespective of the color of the box there located, and in a few instances even when there was no food-box present.

b. Tendency to choose the box from which food had been obtained in the previous trial. This response of course indicated that the effect of actually obtaining and eating food from a certain box was stronger than, and therefore dominated, the effect of having seen food more recently placed in another box. The logical inference is that the interval between trials was too short.

c. Tendency to perseverational response either by choosing box of the same color in trial after trial or by repeatedly rejecting or avoiding a given color. Perseverational tendency seems to vary directly with the baffling character or difficulty of the situation for the subject.

d. In the initial series of experiments, when absolute and relative positions were constant and the animal always found the food where it had seen it placed prior to the interval of delay, response was made immediately with evident ease and certainty, and usually with slight evidence of visual observation of the boxes. But when the conditions were so altered that color became the only constant factor and the sole basis for correct response, the attitude of the subject changed completely, and in place of carelessness of observation, immediacy, and certainty of response, there appeared observational scrutiny, comparison, often recognition; hesitation, delay, and occasionally vacillation; expressions of disappointment, incredulity, mystification; expressions of resentment, anger, depression, and finally, in some instances, refusal to choose.

e. Delayed response to color as isolated factor, although obviously difficult for the chimpanzee, appeared convincingly after delays of at least thirty minutes. This is not a limit, for our experiment is incomplete and our report preliminary and tentative.

5. We therefore conclude that the chimpanzee is capable of a form of delayed response hitherto known and experimentally demonstrated only in man. That it involves representational processes is likely: probably they are symbolic; possibly, imaginal. Whether other primates and still other mammals are capable of this sort of adjustment we do not know. It is entirely possible that this time we have discovered something peculiar to the primates or even to the anthropoid apes. Prophecy, however, would be rash. Experiments are already in progress in the Yale Institute of Psychology to settle the question for the cat and the monkey.

6. Evidences of memory for persons we have obtained in the chimpanzee after intervals of at least ten months; and in forms of buried-food experiment we have demonstrated capacity for correct response after a delay of forty-eight hours, and have obtained in the same experiments indications of mnemonic processes after ninety-six hours.

7. Our results do not suggest age or species differences in mnemonic processes for the four subjects observed. Individual and sex differences are obvious and, we believe, significant. (R. M. and D. N. Yerkes, 1928, pp. 268-270.)

Evidences of mnemonic processes or

forms of memory in the chimpanzee are varied as well as abundant. Is this true also of the similar and yet importantly contrasting processes of creative or constructive imagination? Again we turn to observational data for the answer, and again also we must sample instead of attempting to describe completely the evidences which have become available.

All vertebrates, it appears, are capable of profiting by experience in one fashion or another and more or less rapidly and lastingly. If this implies mnemonic process, it obviously is necessary to distinguish varieties or types of memory. Certainly several types are exhibited by man. Highest among them psychobiologically, and heretofore by many deemed distinctively human, is imaginal recognition and its correlated behavior. The chimpanzee, by contrast, may or may not remember imaginally or recognize with feelings of familiarity. The evidences are, as in case of man, mere indications of experience, but as such they seem to possess similar characteristics and values for chimpanzee and man. Whether or not the mental content of the ape is similar to that of man there can be no doubt of the existence of mnemonic adaptations, but this by no means implies the existence of creative as contrasted with reproductive imaginal processes. The latter, whatever their neurological basis, involve behavioral originality and inventiveness. Therefore in seeking answer to the question, Does the chimpanzee possess imagination? we must examine behavior for marks of novelty of adjustment and originality.

IMAGINATION

As it is entirely impracticable to present observations in detail, or indeed even to refer to all relevant reports, we purpose in the following paragraphs to enumerate the several varieties of behavior and adaptation, which for us have imaginal implications and provide more or less convincing proof of the existence of creative imagination or its functional psychoneurological equivalent. Our exposition is incomplete alike as to categories and description of each. We are attempting merely to indicate some of the principal kinds of positive evidence.

Frequently observed and many times recorded in the literature is invention by the chimpanzee of ways of amusing itself, such as acrobatic contortions or forms of game. Possibly some or all of these are due to imitation, social tradition, tuition, or trial and error selection from among random activities, for in few if any instances has the influence of companions and of human beings been excluded, checked, or controlled. The impression of originality and inventiveness which the animal's activities give the observer may be wholly misleading, but on the basis of our own experience we hazard the opinion that this is only partially the case and that in its forms of play this ape expresses creative imagination.

A second important behavioral category for the student of imagination is the use of ready-to-hand objects as implements. A stick may suddenly be grasped and used to draw food within reach or to push it out of a tube. Granted lack of experience in this type of situation, it would seem that something akin to creative imagination is implied by the behavior. Illustrations of the sudden, direct, and definite use of objects as means might be multiplied from the experimental literature. We desist because several illustrations already have been given in our discussion of types of adaptation, and we shall recur to the subject in a final systematic review of the chimpanzee's use of implements.

More impressive by far than either the invention of games or the use of objects as implements is what may be described as tool-making. Again examples are numerous and excellent. Many times it has been observed by competent students that the young chimpanzee is capable of constructing a pyramid of boxes in order to attain some desired objective. Köhler, it will be recalled, lists several striking instances of the constructive manipulation of sticks. They range from the breaking of a branch from a nearby tree and its prompt use as

implement, through the joining of two short sticks in order that one sufficiently long for effective use may be achieved, to the actual

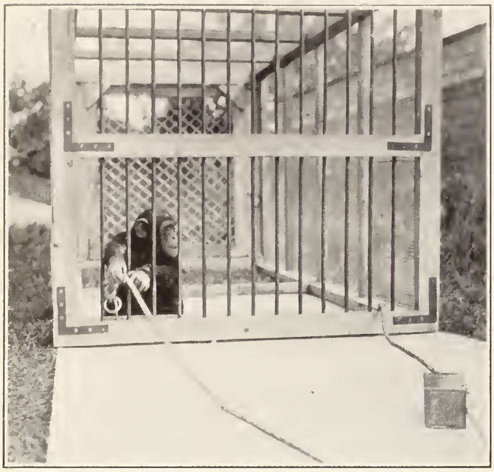


Fig. 115. A hooked-rope problem. The chimpanzee is in the act of removing ring from hook to obtain food-box.

change of size or form of an object in endeavor to adapt it to requirement. Such activities are not commonly observed, but the fact that they have been recorded by certain reliable observers satisfies our critical sense, justifies the presentation of this category, and backed by our own experience convinces us that tool-making tends to establish the existence of creative imagination in the chimpanzee.

Differing somewhat from the above categories, and constituting also an important variety of evidence, is the seeking of an implement when the problematic situation demands it. We cite as instance of such activity search for a key when a closed lock is presented. This may extend even to effort to shape a bit of wood or splinter so that it will fit a keyhole. Or again the animal may seek a stick, pole, or ladder, which although at the time out of sight was known to the subject from previous experience as potentially useful. A peculiarly apt illustration, which however is matched by various observations under experimental conditions, we quote as follows:

Mr. Percival put a preserved cherry into an empty wine bottle.

The cherry was too big to be shaken out, and Toto was faced with the problem of how to secure it. First, he tried pressing one of his long fingers into the neck of the bottle: but the fruit was slippery and he could not keep hold of it. Then he set the bottle down on the table in front of him and considered it. He quickly made up his mind, and looked round the room for what he wanted. On the sideboard stood the remains of a cold fowl. Toto went to it at once, helped himself to a long, thin bone, and put this like a spoon into the bottle. Then he held the bottle upside down and slowly drew out the cherry, balanced on the end of the bone.

It was one of the cleverest things I ever saw him do. My host declared that there was not a native in Central Africa who would have had the intelligence to do it; and for my part I doubt whether many white men would have solved the problem so quickly and so effectively. As I have said, Toto was a genius among apes. (Kearton, 1925, pp. 94-95.)

"Out of sight" is not necessarily "out of mind." If then the needed object is in mind it presumably is both remembered and, as represented, used imaginatively by the chimpanzee. This would appear the simplest way of accounting for such behavioral adaptations as we have cited.

Dreaming constitutes yet another category. It has been reported that the chim-

Fig. 116. Successful solution of the hooked-rope problem. The chimpanzee is pulling the food-box within reach. Unpublished observations of R. M. Yerkes.

panzee moves and makes sounds during sleep which are suggestive of dreaming (Rothmann and Teuber, 1915, p. 13).

Whether or not this is indicative of imaginal processes is unknown, but what is presumably dream behavior establishes another bond of relation between ape and man.

Finally, what may be designated "planned behavior" certainly would ordinarily be thought of as also imaginal. Instances of planning, whether or not involving coöperation with other individuals, are rare in the literature. Köhler has stated that there ordinarily was no systematic coöperation among his chimpanzees in pyramiding boxes or in otherwise endeavoring to solve problems. All might strive for some objective, but generally the striving was individualistic instead of concerted (Köhler, 1925, p. 172). On the other hand, this observer emphatically states that the behavior of an individual often gives one the impression of a planned series of acts, the sum of which is greater than its parts and essentially different from them because of its relation to an objective (1925, pp. 103 ff.). Such evidence is of the utmost importance and would alone suffice to convince many observers that the animal possesses constructive imagination.

A peculiarly apt example of coöperative planning is supplied in the following description by Passemard of the behavior of two adult chimpanzees, mates, named Jimmy and Cucusa, belonging to Madam R. Abreu. Because of the almost unique importance of the observation, and the still greater importance of testing its validity by carefully controlled experimentation, we present the author's account in free and somewhat condensed translation.

The situation was one which demanded that the two animals, who during the day had enjoyed the freedom of an outer cage, be induced to enter a smaller box or cage for the night. The animals refused to enter the box; neither coaxing nor command was effective. Therefore, as the author reports, it was necessary to have recourse to an expedient.

> The male had been permitted to fast since morning and was assuredly hungry. The female had eaten as usual. To increase his appetite, there were placed in the inner cage a large jar of curdled milk, figs, bananas,—all foods of which the male is very fond—in the hope that his greediness would bring him in. It was then that the following events occurred, events which I should have had difficulty in believing had I not myself observed them. To understand well what happened, it is necessary to describe the place accurately. The outer cage is a sort of gigantic colander made entirely of wire-netting on three sides, which rest against one of the small walls of an ancient stable, transformed into an inner cage; the latter does not communicate with the former except by a small door in the wall, which slides horizontally on two rails, one above, one below, in the manner of a wooden cover in grooves; ordinarily it was closed by means of a chain and a padlock. It should be remembered that the male had observed this door working but once or twice and that he had entered the outer cage for the first time this day.
>
> The two apes did not look at the food though knowing perfectly where it had been placed, for, as we had agreed, their attitude had changed when the jar had been placed on the inside; in addition they had heard directions issued in loud tones by their mistress. After they had both wandered about in the vicinity of the door, they settled down face to face, in a corner of the cage, eye fixed on eye, lips rather near, and emitted low sounds perceptible to us; they seemed to be engrossed in a secret consultation whose outer signs escaped us. In an instant, the male on three feet and with disconcerting assurance and calm, turned toward the door, pushed it open on the rails as far as it would go, sat down on the lower rail, his feet braced against the stone frame, his back against the closing of the door. Then the female entered quietly, returning with abundant provisions; these were divided, then eaten. Our plan had been spoiled, we had been defeated. (Passemard, 1927, pp. 247-248.)

It is impossible to evaluate satisfactorily the behavior described by Köhler as indicative of planning and the instance of coöperation given by Passemard. There is no obvious reason for questioning the accuracy of description, and although we cannot precisely match the essentials of either author's observations from our own extensive experience with the chimpanzee, we necessarily accept their reports subject to later verification.

Were it desirable we might increase the number of categories of behavior which possibly, if not probably, are indicative of im-

aginal processes and also the particular illustrative acts. It would seem, however, that typical examples are more important than completeness, for in our opinion the indications are convincing that the chimpanzee possesses both reproductive and creative imagination. That our knowledge of these processes is meager and indefinite is obvious. It is our duty to emphasize this fact, as it is also our privilege and pleasure to point the need and opportunity for fruitful research. There are indeed few assemblages of psychobiological problems which are alike so alluring and so promising of important results as those of mnemonic processes.

INDICATIONS OF ABSTRACTION AND GENERALIZATION

Behavior which the psychobiologist describes in terms of constructive imagination undoubtedly is intimately related to, and perhaps in a measure identical with, that which involves processes of abstraction, generalization, and practical judgment. In the foregoing paragraphs we have considered facts which justify the tentative conclusion that the chimpanzee is capable under certain circumstances of acting imaginatively and that among its behavioral adaptations there must be included the category of construction. It is now pertinent to inquire concerning visible indications of abstraction and generalization.

Accepted by many students as a negative argument is the lack of highly developed vocal language in the ape. Presumably if capable of processes of abstraction and generalization to any considerable degree, it would have developed a system of symbols analogous with human language. In comment on this argument it may be said that speech is only one possible form of language, that intercommunication occurs in the chimpanzee and that it uses a mixed system of symbols which, if completely known to us, might definitely indicate abstraction and generalization.

Turning to positive arguments and evidences, we recognize that there are numerous scattered references in the literature to adaptive acts and other forms of behavior which the authors interpret as dependent upon abstraction, generalization, or both. In the interest of brevity of exposition we purpose, instead of citing such observational fragments, to present what appear to be major categories of evidence and under each a few illustrative examples.

First we would mention the appearance of general adaptation to conditions of experimentation. Many investigators have noted that in the course of weeks or months of experimental work chimpanzees come to exhibit general adaptation, as contrasted with specific habituation. This is of such a nature that the probability of success in a new type of experiment or in the solution of a new problem is greatly increased. It is impossible to describe it more definitely, since the behavior has not been analyzed or its conditions discovered. That the terms abstraction and generalization are applicable is by no means certain. Nevertheless, it seems desirable to suggest the category as one inclusive of activities which in this connection demand critical examination.

Another illustrative instance of general adaptation appears in spread or transfer of training from a particular experiment to others which are similar in principle, although differing in perceptual values. The extent to which this occurs in the chimpanzee has never been determined, although the fact of transfer is established.

As a second category we present the phenomena of general as contrasted with specific training. Instances of what we have in mind appear in the experiments of Köhler on structure-function. In many experiments this observer succeeded in demonstrating the ability of chimpanzees to respond to the relation between two or more objects instead of to a particular object. Confronted by two food-containing boxes the subject by reason of previous general training would consistently choose the larger, even though the particular object selected might in a previous experiment have

Fig. 117. Chimpanzee using a pyramid of boxes which it constructed in order to reach suspended bananas. From W. Köhler, 1921, by courtesy of J. Springer, publisher.

Fig. 118. Boxes arranged as a "four-story structure" by a chimpanzee to obtain suspended food. From W. Köhler, 1921, by courtesy of J. Springer, publisher.

been rejected as the smaller of the pair. Similar capacity to respond to the nearer object, the brighter, the bluer, instead of to a particular box, was demonstrated. Whether or not other mammals than the primates, or even among the primates other animals than apes and man, can in similar fashion and to the same degree with the latter organisms adjust in accordance with relations instead of qualities of specific objects has not been determined. At present the presumption is that this ability is more highly developed, more readily and frequently manifested by the chimpanzee than by any other existing infrahuman organism which has been observed. Therefore we feel entirely justified in presenting the category of general training as possibly indicative of rudimentary powers of abstraction and generalization.

Our third and last category of evidence, although closely related to the previous ones, seems to merit independent description. We term it isolation of perceptual factors. It is illustrated by the experiment previously described (pp. 367-368) in which we demonstrated in the chimpanzee memory of color. More and better instances are supplied by the work of Kohts, who, in training her subject Ioni to respond in varied experimental situations by matching a sample, at once established the possibility of general adaptation through a particular species of training and specific ability to abstract color from size and shape or shape from size and color. These are but instances of the possibility on the part of the chimpanzee of singling out a particular perceptual quality or value of the experimental situation and of reacting on the basis thereof. The same type of process undoubtedly is exhibited in Kohts's observation of the selection by her chimpanzee, from a collection of objects varying extremely in visual qualities, of those which possessed some single quality or character in common. For example, all objects of a particular color would be selected and placed in a receiving box.

We have completed our presentation of general behavioral evidences of abstraction and generalization. As Köhler's findings suggest the sharp limitation of coöperative planning in this anthropoid ape, so those of

Kohts indicate the rudimentariness and also the rarity of abstraction, generalization, and inference in chimpanzee as contrasted with man (1923, p. 491; 1928, p. 275). So extensive, however, is her observational acquaintance with this aspect of the life of a particular chimpanzee that it is eminently desirable to present her conclusions. We shall do this by quoting from a review of the author's Russian text.

Referring to the experiments cited above in which objects were assembled in accordance with color:

Among the interesting conclusions drawn from this experiment are the following: The formation of similarity associations varied in facility and regularity for the different colors: it was facilitated by strong colors and those of maximal saturation; success in sorting or properly placing objects by color was influenced by the qualitative relations of the objects presented as well as by their quantity; similarity associations are markedly disturbed by interruption of work and the readiness with which they are acquired is markedly less than that for association by identity; abstraction in relation to color was not abstraction in the strict sense of that term but rather a practical generalization based upon concrete experience and not on logical conclusions. Once established, however, the type of practical generalization exhibited by this experiment carried over to related situations.

In summing up the principal results of her three years of work with Ioni, Mrs. Kohts presents the following points. The mind of the chimpanzee presents unexpected richness in the components of higher abilities together with limitation in their actual formation. Though there be offered to him all the chief stimulations of the outer world as material for mental elaboration, yet this material will be used only poorly. He is hindered from achieving increased knowledge by lack of external incentive to the perfecting of discriminating abilities and the absence of inner need. Above all, the animal shows capacity for the formation of ideas, but these last in memory only a few seconds. Aroused through every new perception of the external world, which psychically disappears in the present, the chimpanzee has neither desire nor ability to give thought to what has already passed. Although it is true that the ape may show typical general ideas, it causes him great trouble to effect the abstraction even of definite and important characters of concrete things, for he grasps the things by means of unimportant features and appears incapable of isolating the characteristic features. What he accomplishes is a practical generalization resulting from the repeated presentation, as in the experiment, of the several important features or qualities of an object. It seems that the practical conclusions arrived at are based on thoughtful processes. The assemblage of characters from which aspects are gradually disassociated and given importance in the experiments are not used as premises for practical conclusions. The chimpanzee is compelled to execute many trials, some unsuccessful, but finally leading to the solution of his problem and to skill, before he is able to arrive at the practical conclusions necessary for adaptive action. So far as demonstrated in this investigation, Ioni's behavior shows less the element of foresight (called by Köhler "insight") in the sense of primitive fore-weighing or forethought of ends sought than an element of after-sight or after-thought.

This anthropoid ape in many respects stands next to man. Apparently the last word has by no means been said: it must be left to future investigators and more particularly to specialists in the psychology of animals and the psychology of children. United advance in these branches of inquiry will ultimately decide whether the important differences, which are not to be denied between the minds of the highest animals and the most primitive man, appear as a temporary gap in our knowledge or as a far-yawning chasm which can never be bridged. (Yerkes and Petrunkevitch, 1925, pp. 106-107.)

We may fittingly conclude this summary examination of behavioral indications of processes of abstraction and generalization in the chimpanzee by stating that such complexly conditioned adaptive activities are very imperfectly known because rarely observed by trained psychobiologists and up to the present unanalyzed. This is true despite the extreme importance of the subject and its exceptional interest. We may anticipate that in the near future we shall progress from the necessity for vague description of such adaptations to increasingly inclusive and accurate accounts of explicit and implicit organic response and its conditions. Obviously the terms abstraction, generalization, inference, are themselves abstractions which demand enrichment by discovery of facts and perhaps also redefinition.

According to available and reliable data the chimpanzee is much closer psychobio-

logically to man than is the gibbon, and closer even than is the orang-outan. Extension of knowledge may modify this conclusion, but it is not likely to lessen considerably the appearance of similarity between chimpanzee and man. Indeed were it capable of speech and amenable to domestication, this remarkable primate might quickly come into competition with low-grade manual labor in human industry. Again we wish to state that the wealth of observational data on the chimpanzee has compelled selection of illustrative materials, the presentation of principles of method and of conspicuously important trends, definite or tentative conclusions and inferences, as contrasted with such degree of completeness of exposition as was practicable for the gibbon and the orang-outan. We regret this necessity for selective treatment of the subject while rejoicing in the relative abundance of facts and the superior value of the literature on the chimpanzee.

Of the titles included in the general bibliography those which follow have been useful to us in the preparation of an account of the life of the chimpanzee: von Allesch (1921, 1921a), Aschemeier (1921, 1922), Barns (1922, Introd.; 1923), Barr (1797), Bartlett (1885), Bauman (1923, 1926), Beddard (1902), Bergtold (1926), Bingham (1927, 1928, 1929), Blair (1920), Bloch (1900), Boitard (1842), Bolau (1877), Bostock (1911), Bowdich (1819), Brehm (1873, 1922, 1922a), Briffault (1927), Broderip (1835, 1838, 1849), Brown (1879), Buck (1927), Buffon (1766, 1789), Burrell (1923), Calmette (1924), Christy (1915), Crisp (1864), Cuvry (1920), Darwin (1873), Deniker (1882), Descamps (1920), Dexler (1921), Drescher and Trendelenburg (1927), Du Chaillu (1859-61, 1861, 1867), Duckworth (1899, 1915), Duncan (1877), Egmont (1923), Eismann (1886), Elliot (1913), Fick (1895a, 1926), Figuier (1870), Forbes (1894), Fox (1923, 1929), Friedel (1876), Friedenthal (1914), Furness (1916), Garner (1896, 1900, 1905, 1910, 1919), Gervais (1854), Giacomini (1897), Gladden (1914), Gray (1861a, 1861b), Gregory (1910, 1927), Griffith (1827-35), Grünbaum (1902), Grünbaum and Sherrington (1903), Gudger (1923), Güssfeldt (1879), Haberer (1908), Hagenbeck (1909), Haggerty (1910, 1913), Hartmann (1872, 1876, 1885, 1886), Heck (1922), Hemplemann (1926), Hermes (1876), Hirschlaff (1905), Hobhouse (1901), Hollister (1925), Honoré (1927), Hornaday (1903, 1904, 1922, 1925), Huxley (1863), Jardine (1833), Jenks (1911), Jennison (1915), Kearton (1925, 1928), Keith (1896, 1899, 1912, 1914, 1923a), Knauer (1915), Knottmerus-Meyer (1928), Köhler (all titles), Kohts (1921, 1923, 1928), von Koppenfels (1877, 1881), Kroeber (1928), Lang (1924), Lesson (1848), Leyton and Sherrington (1917), Livingstone (1875), Lydekker (1897, 1904), Marbe (1916-17), Martin (1836, 1841), Matschie (1904a, 1914, 1919), Mayer (1851), Meyer (1881), Miller, G. S., Jr. (1928), Miller, O. T. (1887-88), Mitchell, C. P. (1885), Mitchell, P. Chalmers (1911, 1912, 1922), Mitchell, P. C., and Pocock (1907), Mivart (1873), Möbius (1867), Mollison (1908, 1910-11, 1914-15), Monboddo (1774), Montané (1915, 1916, 1928), Nissle (1872, 1876), Noack (1887), von Oertzen (1913), Osborn, A. R. (1912?), Osborn, H. F. (1915), Owen (1849), Passemard (1927), Pfungst (1912), Pocock (1906), Priemel (1908), Pycraft (1914), Reichart (1884), Reichenow (1920, 1921), Rennie (1838), Reuvens (1889), Romanes (1889, 1889a), Romer (1926), Rothmann (1904), Rothmann and Teuber (1915), Rothschild (1904), Royer (1886), Sanyal (1892), Savage and Wyman (1843-44), Scherren (1905), Schmidt (1878), Schultz (1927), Sclater (1889), Sheak (1917, 1923, 1924), Shepherd (1915, 1923), Smith, G. E. (1924), Sokolowsky (1908, 1909, 1915, 1923), Sonntag (1921, 1923, 1924), Spaeth manuscript (1925), Stiles (1926), Stiles and Orleman (1927), Temminck (1835-41), Terrier (1903), Tevis (1921), Tilney (1928),

Traill (1821), Tyson (1699), Ullrich (1919), Walker (1861), Warwick (1832), Waterton (1870), Witmer (1909), Yerkes (1925), Yerkes and Learned (1925), Yerkes and Petrunkevitch (1925), Yerkes and Child (1927), Yerkes, R. M. and D. N. (1928), Youatt (1835-36), Zuckerman (1928).

PART V

GORILLA

GORILLA

CHAPTER THIRTY-ONE

STRUCTURAL APPEARANCE, RACES, DISTRIBUTION, AND HABITAT OF GORILLA

CREATURE of mystery, the gorilla long played hide and seek in the reports of hunters and naturalists. Even now the name holds peculiar fascination because imaginative descriptions abound. Relatively rare, inaccessible, powerful, reputedly dangerous, difficult to capture, and untamable, it has yielded slowly to human curiosity. For centuries rumors of the existence of such a huge anthropoid, native superstitions, and alarming tales stirred popular and scientific interest. Scarcely had it been discovered and definitely described by biologists than it achieved extraordinary importance, for the anatomist Owen recognized it as man's nearest of kin structurally and with characteristic pains indicated the changes necessary to transform gorilla into man. Because of their historical value and very considerable interest at this time we present the eminent anatomist's views in his own words.

To transmute a Gorilla into a Man the chief steps would be as follows:—In the alimentary canal, to develope the mucous membrane of the small intestines into "valvulæ conniventes," and to alter the proportions as to length of the small and large intestines. To abrogate the sexual distinctions of the dental system: to reduce the size of the teeth, especially in relation to the head; to reduce in a greater degree the size of the incisors, and still more so that of the canines, especially in the males, so as to bring the crowns of all the teeth to the same level, admitting, and being followed by, their arrangement in a continuous unbroken series; to alter the shape of the canines and contiguous premolars, and to slightly modify that of the crowns of the other grinding teeth.

In the nervous system, the steps in transmutation would be to abrogate the law of the early arrest of the brain's growth, and to cause it to proceed, especially in the cerebral part, with the general growth and development of the frame, though in a slower ratio: to add to the number and depth of the cerebral convolutions, and to modify their disposition: to augment the size of the corpus callosum, both absolutely and relatively to the cerebellum and medulla oblongata: to expand the cerebrum in all directions, and especially backward beyond the cerebellum, so as to define a "posterior" or "post-cerebellar" lobe: to extend the chief cerebral cavity, or "lateral ventricle," forward beyond the corpus striatum into an "anterior horn," and backward beyond the hippocampus major into a "posterior horn," answerable to the cavity so called in anthropotomy, and with prominences corresponding with Tiedemann's and other anthropotomical definitions of the "hippocampus minor"; the beginnings, or incipient homologues, of which cavity and part are alone present in the highest Apes. (Owen, 1865, p. 51.)

Working as a contemporary of Owen, Wyman (1850, p. 43) disagreed with the opinions which Owen initially published in 1849 and from his observations affirmed that the gorilla is morphologically farther removed from man than is the chimpanzee. That other authorities disagreed with Owen's ranking of the gorilla did not lessen the presumptive value of the animal as illuminator of human history, nor seemingly did the evident contradiction of Owen's opinions by the reports of natives and of naturalists concerning the mental status of the ape.

Even now many authorities accept the gorilla as one of the keys to primate evolution and with the well-informed layman note that fascinating in its mysteriousness, interesting because of its positive values, preëminently important as object of science, this king among the anthropoid apes compels the attention even of those who reject

the idea of organic evolution and are repelled by every infrahuman primate.

HISTORICAL RETROSPECT

We propose now to give a *résumé* of the history of knowledge of the gorilla, although in so doing we shall do little more than summarize the content of Chapter 4 (pp. 27-35); tell of early or peculiarly important captive specimens, and, finally, characterize the scientific literature and thus endeavor to indicate the present status of our knowledge.

Our historical retrospect suggests three eras of knowledge: the prescientific and mythical, the era of discovery or dawn of knowledge, and the period of increasingly exact description. Perhaps in supplementation of this statement we should predict the early dawn of a still more significant era; namely, that of the utilization of this unique creature as an experimental subject for the promotion of biological discovery, invention, and other varieties of constructive endeavor.

As prominent points of reference in the prescientific period we note Hanno, who in the fifth century B.C. used the term gorilla, but probably without knowledge of the ape which we so call; Battell, who in 1625 almost certainly, although with vagueness, described the creature; Monboddo, who is thought to have referred to it in 1774, and Bowdich, whose publication in 1819 marks the transition from the prescientific era to the dawn of definite knowledge. We have omitted mention of the great naturalist Buffon, for although he was acquainted with the creature through the writings of Battell, he unfortunately confused the issue by the misapplication of names and thus for decades delayed the scientific discovery and exact description of the gorilla.

It was in 1847 that Savage and Wyman, by their joint contribution, discovered this animal to the scientific world and established a description to which all subsequent authors have carefully referred. Following them Owen, beginning with the year 1848, made numerous contributions to knowledge of the ape, and finally in 1865 published a monograph which still continues to be a useful reference. Knowledge of the creature's mode of life traces also through Gautier-Laboullay (letter dated 1849, published in 1858-61) to Du Chaillu, who in 1861 by his graphic, if perhaps exaggerated, descriptions of the experiences of a hunter-naturalist awakened the interest of the world. In the meantime, in France, de Blainville, Duvernoy (1855-56), and finally, Isidore Geoffroy-Saint-Hilaire (1858-61), devoted themselves to the study of specimens. The latter, like Owen, published a monographic account of the animal which because of its historical section and its comprehensiveness is of continuing usefulness. We may appropriately conclude this historical review by remarking that as Savage and Wyman heralded the discovery of the gorilla, so Du Chaillu exploited it and through his popular books and lectures made familiar to tens of thousands of persons an animal which had previously been known to only a few scientists and hunters.

The reader who wishes to acquaint himself more intimately and thoroughly with the history of the discovery of the gorilla and with progress toward exact knowledge thereof will find the following chronological list of references serviceable. Gervais (1854), I. Geoffroy-Saint-Hilaire (1858-61), Du Chaillu (1861), Gray (1861b, 1861c), Sanford (1862), Huxley (1863), Reade (1864), Owen (1865), Bischoff (1867), Bastian (1873), Burton (1876), Hartmann (1880), Garner (1896), Lydekker (1897), Grabowsky (1904), Heck (1922), Barns (see especially preface by Johnston, 1922), Akeley (1923, 1923a), Yerkes (1927), Maxwell (1928), Burbridge (1928).

The facts now to be recounted relative to early, or for other reasons famous, captive gorillas, indicate that the animal is much more difficult to secure and maintain in captivity than are the other anthropoid apes; that rarely have adult specimens been procured alive and held captive, and that in all probability no one has had oppor-

tunity to study the full-grown animal except in Africa. It would be idle to attempt a complete description of the history of living captives. We shall content ourselves with brief mention of the first specimens exhibited in important centers of civilization and a similarly brief account of the few captives which have figured conspicuously as exhibits or scientific subjects.

In 1855 there was shown in England as a chimpanzee named Jenny an ape which was subsequently identified as a young gorilla. It is known in the literature as Wombwell's gorilla. The first description which we have discovered is that of Waterton (1858, pp. 62-67), who mistook the animal for a chimpanzee. This specimen, which seemingly was the first living gorilla to reach Europe and to be presented as an exhibit, Waterton tells us, continued with the menagerie until it reached Warrington where "without any previous symptoms of decay, Jenny fell sick and breathed her last." Further information about this first European gorilla may be found in Sclater (1877), Keith (1896), Scherren (1905), and elsewhere. Confusion of dates appears, in that certain authors refer to the animal as exhibited about 1860.

The second European specimen, and the first to be exhibited in Germany, apparently is the Falkenstein gorilla which in June, 1876, was purchased from Dr. Falkenstein by the Berlin Aquarium for the sum of twenty thousand marks. The early history of the individual is given by Falkenstein (1876, 1879), and the first account of its life in Europe is given by Sclater (1877). The Falkenstein gorilla was a male which when received in Berlin weighed about thirty pounds. It survived until November, 1877, having spent about sixteen months in captivity.

What appears to have been the first specimen to be exhibited in France is described by Milne-Edwards (1884) as a male estimated as about three years of age. Presumably the animal arrived in Paris in 1883. He survived for a short time (Keith, 1896, p. 26). Concerning his disposition Milne-Edwards remarks that it is very different from that of the chimpanzee or the orang-outan, the creature being savage, morose, and brutal (1884, p. 959).

Hornaday in 1904 wrote that up to 1903 only one gorilla had been landed alive in the United States, and it, a tiny specimen, lived for only a few days after arrival. In a letter to the authors dated April 17, 1928, W. Reid Blair, Director of the New York Zoölogical Park, writes:

Fig. 119. A drawing of the Wombwell gorilla. From Sclater, 1877, Proceedings of the Zoölogical Society of London.

> Sometime in 1898 there was a report of the arrival of a baby gorilla in Boston but it is my impression that this animal died on shipboard. We have no record of its having reached any zoological garden or circus.
>
> Our first gorilla was a female about two and one-half years of age, which was brought to the Zoological Park by R. L. Garner in 1911. It was obtained in Equatorial West Africa. When it reached here on September 23, 1911, it was in such poor physical condition that it died on Octo-

ber 5 from malnutrition and starvation. It was 34 inches in height but weighed only 25 pounds.

Our second gorilla was the female "Dinah." She reached us on August 21, 1914, and died on July 31, 1915, after having been on exhibition in the Zoological Park for 11 months and 10 days. She had, however, been in captivity about two years, one year of this time being spent in Africa where she had been under the care of the Society's agent, the late Richard L. Garner. The cause of death in this case was malnutrition and rickets. Dinah weighed, on November 15, 40½ pounds. Her standing height was three and one-half feet and the extreme spread of her arms and hands between the tips of the middle fingers was 4′ 2½″. At the time of her death she was somewhat emaciated and weighed somewhat less than forty pounds. We judge that she was four years old at the time of death.

The wide spacing of the dates of these several first specimens in different countries is at once surprising and we believe indicative of the peculiar difficulties which were experienced in maintaining captives. The literature contains references to a score or more of attempts which were made between 1860 and 1890 to import exhibition specimens. That the situation is changing in the direction of increased success in keeping captive gorillas is very definitely indicated by the facts concerning more recent and at the same time conspicuously important specimens which we now relate.

Among the so-called famous captive gorillas the Breslau specimen "Pussi" takes first place chronologically and also in length of life in captivity. By Grabowsky (1904) we are informed that she was purchased in Liverpool in September, 1897, being then about four years old and weighing thirty-one and one-half pounds. In August, 1904, she weighed sixty-six pounds. When Pussi died in October, 1904, she had been seven years in captivity. We shall have occasion to refer to various observations made on this specimen.

In December, 1906, a young male gorilla was obtained for exhibition in Dublin, but it survived only a few weeks. A young female was obtained from the Gaboon in January, 1914. This specimen, which was given the name Empress, died in May, 1917, after a period of three years, four months, in Dublin. A scientifically valuable account of the subject is given by Carpenter (1917).

John Daniel, or Johnny Gorilla, is the name of a specimen which was kept in London by Miss Cunningham from 1918 until 1921. Because of its rapidly increasing size and strength it was then sold to an American circus. It died in New York soon after its arrival there in April, 1921 (Cunningham, 1921).

Fig. 120. "John Daniel," the Cunningham specimen of *G. gorilla* mounted. Courtesy American Museum of Natural History.

Another specimen of West African gorilla, for so far as we know all of the captives which we have mentioned are from

the West Coast of Africa, was obtained by Miss Cunningham in 1923. To this animal she gave the name Sultan, although when exhibited in the United States in 1924 it was known also as John Daniel II. Like

Fig. 121. The Cunningham gorilla "Sultan" or "John Daniel II." A young male *G. gorilla*. Courtesy of Alyse Cunningham and Thomas Fall, photographer.

John Daniel, his predecessor, Sultan for some years continued in excellent health and increased rapidly in size. At various times he was exhibited in London and on the Continent as well as in the United States. He died in London in 1927 (authors' notes).

In the fall of 1925, the American hunter Ben Burbridge brought into New York the first specimen of mountain gorilla (*Gorilla beringei*) to be brought alive to the United States (Yerkes, 1927). As far as we have been able to discover, Burbridge brought the first living specimens of this species of gorilla to Europe. In 1922 he delivered a young male to the Belgian Zoölogical Garden in Antwerp, and in 1925, on his way to the United States with the specimen named Congo, he left at Antwerp a second young male. We are informed that the Antwerp specimens died within a few months of arrival. Congo, a female, whose age when captured was estimated as approximately four years, was kept near Jacksonville, Florida, from October, 1925, until March, 1927. She was then transferred to Sarasota, Florida, where she has since been kept by Mr. John Ringling. At the date of writing she has been in this country about two years, and throughout that period has continued in excellent health and has grown steadily and rapidly.[1]

During the years 1927-28 at least five infant gorillas from West Africa were brought into the United States. One, which we shall later refer to as "Bamboo," was purchased for the Philadelphia Zoölogical Garden. He has been exhibited for more than a year, at the date of writing, and continues to thrive. The National Zoölogical Park has a specimen; the New York Zoölogical Park another, and two individuals are known to have died.

The information concerning captive specimens which we have presented above has been drawn chiefly from the following list of references. The interested reader may, if he so desires, obtain more details and also knowledge of additional specimens by consultation of the references. Waterton (1858), Duncan (1877), Sclater (1877), Milne-Edwards (1884), Deniker (1891), Hermes (1892), Keith (1896), Lydekker (1897), Grabowsky (1904), Hornaday (1904), Scherren (1905), Carpenter (1917), Cunningham (1921), Heck (1922), Lankester (1922), Barns (1922, 1923), Yerkes (1927, 1927a, 1928), Burbridge (1928).

Certain interesting characteristics of information concerning the gorilla appear in the literature. Up to 1877 the records indicate persistent tendency toward confusion of the animal with other types of anthropoid ape. Subsequent to that date the genus was definitely established and discussion of spe-

[1] Congo died at Sarasota in April, 1928 (Yerkes, 1928, p. 79).

cies, races, and varieties began to appear. Knowledge accumulated slowly and superstitions persisted. From 1860 the anatomy of the organism became increasingly well known, whereas concerning mode of life or natural history relatively little was known prior to Du Chaillu's publication in 1861. Since that date, study of the life, as contrasted with the structure, of the gorilla has made surprisingly little headway. The psychobiology of the ape continues to be practically unknown, and despite its biological uniqueness the gorilla has seldom been used as an experimental object.

There is a far greater abundance of literature on the life of the gorilla than on that of the gibbon and orang-outan, although less than for the chimpanzee. The materials of our present chapters are based mainly on the contents of approximately one hundred and seventy references. But of these not more than a score present signally important contributions to or accounts of the life of the ape.

Natural histories, prior to the writings of Buffon, fail to mention the gorilla, and in the works of the latter there is meager and uncertain description, with occasional confusion of the types of anthropoid ape then known. The notable books of Rennie (1838) and Martin (1841), which we have so often referred to in our descriptions of the life of the gibbon, orang-outan, and chimpanzee, contain no mention of the gorilla. The first general naturalistic description of which we have knowledge is found in Gervais (1854). But of far greater importance historically and as assemblages of useful information are the monographs of I. Geoffroy-Saint-Hilaire (1858-61) and of Owen (1865). For the reader who with minimum effort would acquire a fairly inclusive, if not complete and detailed, picture of the life of the animal, the most useful recent publications are those of Reichenow (1920), Heck (1922), and Yerkes (1927, 1927a, 1928). Of these the first is primarily an original contribution to the natural history of the wild animal; the second, an inclusive general description of mode of life; and the third, an account of the psychobiological characteristics of a mountain gorilla.

STRUCTURAL CHARACTERS

Largest and most powerfully built of all existing anthropoid apes, the gorilla is readily distinguishable from the other types by its greater size, shorter arms, and larger nose.

> The Gorilla may be distinguished in life from the Chimpanzee by its sullen, untamable, ferocious nature; its long nasal bones descending far below the level of the infra-orbital margin; its great alar nasal folds running to the margin of the upper lip; its great peculiar molar, premolar, and canine teeth; its broad, short, thick webbed hands and feet; its long heel and the great length of its upper arm with the smaller development of the forearm. (Keith, 1899, p. 312.)

The striking features of configuration are its large, strongly built body, with immense chest, broad back, huge shoulders, protruding abdomen, heavy arms reaching somewhat below the knees, stout legs, and characteristics of head and feature. Quite evidently it is built for strength rather than speed, for life on the ground rather than in the trees, and although the inference is not wholly justified by appearances, they at least suggest specialization in brawn instead of brain. The tempo of gorilla life appears to be much slower than that of the gibbon and chimpanzee, and its reactions are relatively slow.

In lieu of satisfactory data on size, strength, and vitality, we discover in the literature guesses, estimates, and in a few instances reliable measurements. Analysis and evaluation of the data justify the tentative statement that in height the adult gorilla may range from five to six feet, in weight from two to four hundred pounds, in accordance with sex and variety. For a large male specimen of *Gorilla beringei* Barns (1922, p. 87) gives the weight as approximately 450 pounds; standing height, 63¾ inches; span of arms, 90 inches; chest girth, 61 inches; forearms, 16½ inches; length of foot, 12 inches; and length of hand, 10 inches. The same author, com-

menting on report of a nine-foot gorilla, remarks:

> I am quite certain that these splendid apes never attain a standing height of more than 7 feet—if that! The largest one shot by the writer measured 6 feet 2 inches from heel to crown, and I believe it to be a record measurement. The girth of chest sometimes reaches to a little over 60 inches. The span (and reach) of the tremendous arms is very great, 8 feet being quite usual in a fine male, whilst the forearm and biceps may reach to 19 inches. (Barns, 1923, p. 131.)

Barns's estimate of weight is questioned by Akeley, who reports that his measurements for a large male of the same species which actually weighed 360 pounds are greater than those given by Barns for the specimen whose weight approximated 450 pounds (Akeley, 1923a, p. 441).

Useful as aid to visualization is the following comparison of Akeley's 360-pound specimen with the pugilist Dempsey:

> Although not so tall as Dempsey, the gorilla weighs nearly twice as much, and his arms are longer and more powerful. But his legs, on the other hand, are much shorter. Unquestionably a well-developed man can travel both faster and farther than a gorilla. (Akeley, 1923, p. 232.)

	Gorilla	*Dempsey*
Height	5 ft. 7½ in.	6 ft. 1 in.
Weight	360 lbs.	188 lbs.
Chest	62 in.	42 in.
Upper arm	18 in.	16¼ in.
Reach	97 in.	74 in.
Calf	15¾ in.	15¼ in.

The following statement relative to racial differences and variability of height is quoted from Rothschild (1923, p. 177):

> Adult males of the three well-defined races vary in height from 5 ft. to 6 ft., and there is no specimen preserved over 6 ft. in height, but in the "Illustration" for February 14th, 1920, p. 129, is a photograph of a gorilla 9 ft. 4 in. in height, according to M. Villars-Darasse, and the photograph certainly shows a gigantic animal. This individual is said to have been killed in the Forest of Bambio, Haute-Lobaze.

Additional data and discussion thereof may be found in Hartmann (1885, p. 236), Friedenthal (1914, p. 74), Aschemeier (1921, pp. 91-92), Heck (1922, p. 679), Schultz (1927, pp. 17-18), and elsewhere. Evidently the adult gorilla, irrespective of sex, species, or race, is an immense creature, many times exceeding the gibbon in weight and height, and perhaps on the average nearly twice as heavy as either the orang-outan or chimpanzee.

Descriptions agree in attributing to the gorilla extraordinary muscular power. There are many hunters' tales which suggest that both relatively and absolutely the strength of the animal is much greater than that of any other anthropoid ape and probably several times that of man. It would be idle to quote or even to cite instances of the tearing off of limbs of trees, the breaking of saplings or of sizable sticks, the bending of gun-barrels, and like evidences of the muscular power of individuals enraged by pursuit or injury. It is significant that the only measurements available support the impressions of hunter-naturalists in indicating in the gorilla much greater strength relative to weight than in man.

With a rope arranged so that the subject pulled against a spring balance in an effort to obtain desired food, Yerkes obtained crude measurements of the strength of arm in a female whose age was estimated as four to five years and whose weight was sixty-five pounds. Working with both arms, feet braced, the subject pulled one hundred and sixty pounds. A year later, with body weight of one hundred and twenty-eight pounds, a pull of two hundred and forty pounds was recorded, but, as the observer remarks, this was without maximal effort (Yerkes, 1927, pp. 14, 82; 1927a, pp. 384-385). It is estimated that this performance on the part of the young gorilla indicates a strength of arm not less than two or three times the human.

Of the vitality or tenacity of life in this great ape little can be learned from search of the literature. There are many references to inability of the creatures to withstand captivity and also a few conflicting statements about resistance to injury or succumbing to gunshot wounds. One may not legitimately infer from the information that

Fig. 122. A group of mountain gorillas mounted by Carl Akeley. Courtesy American Museum of Natural History.

the gorilla differs greatly from the other great apes in endurance, vitality, or ability to withstand dangerous injury.

Recurring to appearance or configuration, we would note that there is characteristically a heavy coat of hair, which occasionally on the back or limbs may attain a length of at least ten centimeters. In the adult the face, palms, soles, and often the upper portion of the chest, are bare or carry small, inconspicuous growth of hair. In color the hair varies somewhat with race, age, and sex; commonly it is black, but it tends to become lighter with age, and there is authority for the statement that in many specimens the hairs normally carry at their tip, and also at their base, rings of white. The male, beyond maturity, becomes light or white-backed, and in some specimens the hair of the head appears rufous. For serviceable descriptions of the structure, general appearance, and distribution of the hair we

would refer to Fritsch (1918), Heck (1922, p. 679), and Schultz (1927, pp. 20-22).

On the authority of natives, albinism, or at least the occurrence of white or light-coated specimens, is reported by Ford (1852-53, p. 31), and Garner (1896, pp. 208-211) remarks:

A white trader living on this lake claims to have seen a gorilla which was perfectly white. It was seen on the plain near the lake. It was in company with three or four others. It was thought to be an albino, but in my opinion it was only a very aged specimen turned grey. A few of them have been secured that were almost white. It is not, however, such a shade of white as would be found in an animal whose normal colour is white. I cannot vouch for the colour of this ape seen on the plain, but there must have been something peculiar in it to attract so much attention among the natives.

The color of the skin also is typically black, although there are variations toward brown and steel gray, related possibly to species but certainly also to age and climatic and nutritional circumstances. It is established that sweat glands exist in the skin of at least certain portions of the body, and it has been noted by several observers that the perspiration has a strong and peculiar odor unlike that of any other anthropoid ape.

The gorilla [says Aschemeier (1922, p. 177)] has an odor almost as characteristic and prominent as its terrific yell. To describe this odor is quite impossible. It is pungent, and smells a bit like rubber. Often while walking along we would suddenly detect the odor of the gorilla, and on investigation find where the animals had passed or had stopped to eat.

They emit a rather pronounced musk-like odor, a little similar to that of certain negresses, but it is not disagreeable, is the statement of Petit (1920). Whereas the statements of Aschemeier and Petit undoubtedly refer to the West Coast gorilla, the existence of peculiar odor is affirmed also in the case of the Central African or mountain gorilla by Burbridge (1928, p. 279) and by Yerkes (1927, p. 15), whose description of a captive immature female *G. beringei* includes the following:

Sweat glands apparently are numerous and widely distributed, for drops of perspiration were frequently observed on the extremities as well as on the head and face. The secretion has a pronounced odor which by certain observers is said to be similar to that of the Negro. The writer has not been able to confirm the latter observation.

The head of the gorilla is relatively large, the brow and chin somewhat receding, despite the large supra-orbital ridges and the heavy lower jaw. The ears are small, set close to the head, and more closely resemble the human than do those of any other existing anthropoid. The eyes are relatively large, deep-set, and in color range from light to very dark brown. By reason of its size and peculiar conformation, the nose is the conspicuous as well as central feature. It has a long bone, a conspicuous bridge, and at its base flattens into a large triangle, the wings of which merge into the upper lip. The nostrils are very large. Partly because of the configuration of the nose, the upper lip, although large and full, is relatively short. The lower lip is short and thick. It seldom is protruded as by the chimpanzee. The mouth is large. Because of the large tusk-like canines the teeth of the adult gorilla are conspicuous.

Chiefly because of its relatively short neck and the limitations of head movement, the appearance of the gorilla is often likened to that of the bear. In the adult of the genus there is no obvious line of demarcation between head and trunk; instead, a continuous curve appears. Peculiar also to this type of anthropoid, possibly even to certain races, and probably most pronounced in the old males, is the so-called head crest. In females of the genus it is little more than a ruff or ridge of hair on the back of the head, which at times becomes erect. In the male, however, it is much larger and apparently results from the growth of subcutaneous tissue over the occipital region. Our present information limits this structure to *G. beringei,* in the males of which it is very conspicuous.

Laryngeal sacs, which in earlier chapters have been described as of peculiar interest in the orang-outan, occur also but in less

marked development in the gorilla. On the authority of Deniker and Boulart (1886, p. 57), it may be stated that two laryngeal sacs, often unequal in size, one on either side, occur in the adult gorilla.

Much attention has been given to the structure and proportions of the arms and legs, hands and feet, fingers and toes, for all things considered they appear more closely to approach the human characters than do those of any other primate. The arm, shorter than in other anthropoids, extends somewhat below the knees. It is longer than the human, absolutely and also in proportion to the length of leg. Schultz, who has published the most significant comparative study of growth and physical measurements in the great apes and man, from his data concludes that in at least one form of gorilla the forearm is relatively as short as in man, whereas in this respect the chimpanzee, orang-outan, and gibbon are far removed from man, since in them its length approaches or even surpasses that of the upper arm (1927, p. 35). The morphologists inform us that the gorilla hand is broader, the fingers relatively shorter and heavier than in other anthropoids, and the entire structure relatively less suitable for arboreal life.

Despite the sketchiness and utter inadequacy of this characterization of gorilla appearance and physique, we must proceed, after citation of morphological sources, with our exposition of psychobiological facts.

The following authorities and publications represent preëminently useful, early and late, general accounts of, or signally important contributions to, the morphology of the gorilla. The reader who wishes to acquaint himself fully with the pertinent morphological literature will discover in the publications of these several authorities an exhaustive bibliography as well as an invaluable array of facts. Duvernoy (1855-56), a comparative treatise; Owen (1865), historical and general; Broca (1869), nervous system primarily; Hartmann (1880, 1885), general; Ehlers (1881), comparative morphology of gorilla and chimpanzee; Keith (1896), synopsis of morphological literature to date, and bibliography; Sonntag (1924), summary description of the morphology of the great apes, and bibliography; Schultz (1927), a comparative study of growth and physical measurements in the great apes, with bibliography which importantly supplements those of Keith and Sonntag.

SPECIFIC AND OTHER VARIATIONS

The psychobiologist is necessarily interested in structural characters or variations which condition behavior. There is little indeed to suggest specific behavioral differences in the genus gorilla, but nevertheless it would be inexcusable to neglect in this connection examination of the findings and opinions of specialists in the field of classification and also of those morphological variations which are correlated with age, sex, or individuality, although not necessarily specific. Reichenow, a preëminently important contributor to the natural history of the gorilla, from his experience remarks that although gorillas observed in different regions did not vary noticeably in biological respects, it is not legitimate to assume that there are no significant behavioral differences, and, he continues, "a comparison of my findings in respect to the manner in which the gorilla builds his camp shows noteworthy differences from the accounts of such trustworthy observers as Koppenfels and Oertzen" (Reichenow, 1920, p. 3).

Survey of the taxonomic literature on the genus gorilla reveals three periods which differ markedly in the nature of interest and the trend of contribution and opinion. The first of these epochs, dating from the discovery of the ape to science in 1847 and continuing for nearly fifty years, is marked by general acceptance of the genus and absence of definite knowledge of the existence of well-marked species. In his *Hand-book to the Primates* Forbes in 1894 (II, 180) describes *Gorilla gorilla* as the single species of the genus.

The second period is marked by activity of French, German, and English taxono-

mists in the discovery, or perhaps descriptive creation, of species and varieties. In the midst of the era appeared Elliot's *Review of the Primates,* in which are described (1913, III, 206 ff.) two species, *G. gorilla* and *G. beringeri* (properly beringei), and four subspecies: matschie, diehli, jacobi, and castaneiceps. Elliot's dissatisfaction with the status of taxonomic information is manifest, for he writes:

> There have been a number of species and races described at various times, on what must be considered as very inadequate material, for it is not easy to secure specimens in sufficient numbers and of various ages, to obtain the necessary knowledge of the coloring of the pelage from infancy to old age, and also the differences which may exist caused by the sex of the individual. A number of the races, accepted at present, rely mainly if not entirely for their distinctive characters on the color of their pelage and its method of distribution, but this may be caused entirely by the age of the individual, and it appears to be the general opinion of those who have had any experience with the wild Gorilla, that the older the male is the grayer he becomes, until, if he lives long enough, he is almost entirely gray, being then in a pelage resembling that of the very adult specimen in the Berlin Museum from Mokbe, southern Cameroon. It will require a large series of examples from youth to old age to exhibit the changes that take place during life, before this can be definitely ascertained, and the distinctive value of the present accepted races can only then be decided. (1913, III, 209.)

It was during this period that the German systematist Matschie industriously added to the steadily growing list of species and subspecies, races, or varieties. As one reviews the several publications of this observer he comes to feel that to Matschie, wherever a few gorilla specimens were brought together, there appeared the possibility of discovering a variant worthy of a new name. It was in 1903 that Matschie established, on the basis of a specimen killed on the western border of German East Africa by Captain von Beringe, the species *Gorilla beringei.* In this connection it is important to note that even by Matschie himself the specific name is sometimes spelled *beringeri* and sometimes *beringei.* This has resulted in confusion, since many authors have followed the incorrect usage, *beringeri.* We have attempted to use *beringei,* obviously the correct designation, consistently. In 1904 Matschie lists as species, *Gorilla castaneiceps, G. beringei,* and *G. diehli;* a publication in 1905 adds to the list *matschiei* and *jacobi,* and in 1914, *graueri.* Thus the work continued throughout the life of this investigator, species and subspecies being created endlessly.

The transition to the third period mentioned above, during which opinion came to favor a single species, with racial variants, is marked by Rothschild's description of the species and four geographical races: *Gorilla gorilla* (Gaboon); *Gorilla gorilla matschiei* (South Cameroons); *Gorilla gorilla jacobi* (West Central Cameroons); *Gorilla gorilla diehli* (North and Central Cameroons); *Gorilla gorilla berengeri* (Kirunga, German East Africa).

> It may appear ridiculous to some that the Gorillas of the Cameroons should be divided into 3 races, but I must remind my readers that these large Apes, like the Orangs, probably cannot swim and therefore these races are separated and entirely isolated by the large rivers. (Rothschild, 1906, p. 466.)

This author further confirms and supports his opinion that there exists only a single species of gorilla, with subspecies or local races and variants, due perhaps to dimorphism, in a later publication from which we quote the following highly significant paragraphs:

> The three following subspecies, or local races, are well defined and distinct: Gaboon Gorilla (*Gorilla gorilla gorilla* Savage & Wyman); Cameroon Gorilla (*Gorilla gorilla diehli* Matschie); Mountain Gorilla (*Gorilla gorilla beringeri* Matschie). The Gaboon and Cameroon Gorillas, as distinguished from the Mountain Gorilla, are dimorphic, *i.e.* they have a black and a red phase; in the Gaboon race the red phase does not differ in colour on the body, but has the whole crown chestnut rufous, whereas the Cameroon race has a rufous phase in which the red crown is less sharply defined, and the body-colour brown or more mixed with rufous hairs. These rufous phases have been described respectively as distinct species or races as follows: Gaboon race, *Gorilla castaneiceps* Hack., and the Cameroon race *Gorilla gorilla mat-*

schiei Rothsch.; they must, however, stand as *Gorilla gorilla gorilla* form. dimorph. *castaneiceps,* and *Gorilla gorilla diehli* form. dimorph. *matschiei.*

Fig. 123. Mounted adult specimen of *Gorilla gorilla.* Courtesy of F. W. Bond, photographer, and Zoölogical Society of London.

The Mountain Gorilla is at once distinguishable externally from the two other races by the much stouter and more stocky build, by the much thicker pelage, by the intense shining black of the hair, and by the large fleshy callosity or crest on the top of the head. This crest was first noticed by Mr. Barns, and his photographs of the animal in the flesh were the first intimation to systematists of this peculiarity. This callosity is similar in its nature to the cheek callosities of the Orang Outan, but unlike these, appears to be common to all adult males, and not a sign of senile impotence as in the Orang.

The most essential differences of the three races are, however, in the skulls. . . . (Rothschild, 1923, p. 176.)

We have described at some length the history of classificatory description of the gorilla in order to exhibit certain prevalent sources of error in such work and the probability that other than specific differences are significant for the psychobiologist. We have no right to opinion on the basis of original observation concerning specific characters and values in this ape, but our usage throughout the volume is such as to suggest the recognition of two types which may possibly turn out to be true species; namely, *Gorilla gorilla,* the lowland form, which probably exists in several local subspecies, and *Gorilla beringei,* the highland or mountain form, which in all probability also differs locally. In fact, two races or subspecies, the one originally named *beringei* and the other *graueri,* have been described.

Since these paragraphs on classification were written we have had opportunity to read in manuscript *A Review of the Genus Gorilla* by Harold J. Coolidge, Jr. On the basis of skull measurements this observer offers the following opinion:

After taking all things into consideration my conclusion is that the gorilla, particularly the adult male, shows a large individual variation even within the limits of a small area; that there is no difference in kind between the Coast and the Mountain Gorillas such as to justify making of them two separate species, but that there is a distinct difference in degree sufficiently important to constitute a subspecific difference between the two groups. . . .

Revised Classification

Genus and Species:

Gorilla gorilla

Gorilla gorilla gorilla

(Savage and Wyman)—*Coast*

Gorilla gorilla beringei

(Matschie) *Mountain*

The external characters that distinguish the *Mountain* from the *Coast* gorilla are, besides a longer palate and a generally narrower skull, the

thicker pelage, shorter arms and longer legs, large amount of black hair, and fleshy callosity on the crest. (Coolidge, 1929?)

A somewhat embarrassing complication for the student of classification results from the existence of what seem to be forms intermediate between the chimpanzee and the gorilla. The appearances naturally suggested to various observers hybridization. Against the probability of the crossing of the genera is the prevalent belief that chimpanzees and gorillas do not intermingle, though as I. Geoffroy-Saint-Hilaire (1858-61, p. 56) pointed out, they may inhabit neighboring territory. To various authorities the widely differing morphological characters and the nature of social relations in the genera constitute negative arguments. Nevertheless, the existence of forms which are with difficulty classifiable as either chimpanzee or gorilla is established and the necessity for explanation is evident. The problem may best be exhibited by reference to specimens which have figured in the literature as classificatory puzzles.

Fig. 124. Mounted specimen of mountain gorilla. Courtesy of F. W. Bond, photographer, and Zoölogical Society of London.

There was brought to the Dresden Zoölogical Garden in 1874, from the Loango coast of Africa, an anthropoid ape which is known in the literature as "Mafuca." The peculiarities of appearance (see fig. 75, p. 211) and behavior of this ape aroused curiosity, and eventually various authorities were called to Dresden to examine her and pronounce judgment concerning classification. We shall list the opinions of several of these observers and give references to the more important literature on the controversy which lasted for several years.

Bolau (1876, 1877) pronounced Mafuca a chimpanzee; Meyer (1876, 1881, 1881a) agreed with Bolau, and expressed the opinion that she was neither a gorilla nor a hybrid. By Hartmann (1876a, 1877, 1880) Mafuca was classified as a young gorilla, and Nissle (1876) also believed her to be a gorilla. Brief account of this interesting controversy is given by Keith (1896, p. 32).

A strong advocate of hybridization as explanation of this classificatory puzzle is von Koppenfels, who as evidence of crossing offers personal observation of the association of gorillas with chimpanzees in their native habitat. He clearly indicates his conviction thus:

> I believe it is proved, that there are crosses between the male *Troglodytes gorilla* and the female *Troglodytes niger,* but for reasons easily understood, there are none in the opposite direction. I have in my possession positive proof of this. This settles all the questions about the gorilla, chimpanzee, Kooloo Kamba, N'schigo, M'bouvé, the Sokos, Baboos, etc. (Von Koppenfels, 1881, p. 448.)

By some authorities Koppenfels' evidence of hybridization is considered unconvincing and his explanation of forms intermediate

between chimpanzee and gorilla therefore unacceptable. For example, Garner, who unquestionably had excellent opportunity to gather information, thus opposes his position:

Fig. 125. Gorilla or chimpanzee? A young male chimpanzee which was mistaken for a gorilla. Courtesy of J. L. Buck.

The ape known as "Mafuka," which was exhibited in Dresden in 1875, was also brought from the Loango coast, and it is possible that this is the ape to which the native name *pongo* really belonged. This specimen in many respects conforms to the description of the *ntyii* given, but the idea suggested by certain writers that "Mafuka" was a cross between the gorilla and chimpanzee is not, to my mind, a tenable supposition. It would be difficult to believe that two apes of different species in a wild state would cross, but to believe that two that belonged to different genera would do so is even more illogical. (Garner, 1896, p. 255.)

Pertinent also to this discussion of hybridization is the case of the exhibition specimen Johanna, a well-grown female ape exhibited in America and England by the Barnum and Bailey Circus and subsequently lodged in the Zoölogical Garden of Lisbon. By Duckworth (1899) she is referred to as an unclassifiable ape which, although sometimes considered a gorilla, more likely is a form of chimpanzee, inter-

Fig. 126. The male chimpanzee "Chim," observed by Yerkes. He resembled the gorilla more closely than do most examples of his genus. Courtesy of N. E. Lewis.

mediate between gorilla and chimpanzee, and similar to the *"Kulu-Kamba"* of Du Chaillu and the famous specimen Mafuca (p. 157).

Peculiarly important is the comment of Keith.

> "Johanna" is of interest because she represents a variety of Chimpanzee which approaches the Gorilla in so many points that it is evident the characters which separate the two African anthropoids are not so well marked as many suppose. The difficulty of distinguishing the one from the other, as shown by a recent communication by Mr. Duckworth to this Society, is such that it has become necessary to sum up, from a much wider examination of material than has ever been at anyone's disposal before, the structural and physiological differences which separate the Gorilla from the Chimpanzee, and at the same time to sum up the evidence as to the existence of one or more species of Chimpanzee. Some five years ago, on working minutely over all the anthropoid material in the collections of the Natural History Museum at South Kensington and the Museum of the Royal College of Surgeons, which contain the skulls of 31 Gorillas, 44 Chimpanzees, 73 Orangs, and 56 Gibbons, I was struck by the fact that nearly all the characters which had been used to differentiate species were points which varied in structure and form with age, sex, and the individual, but I have never had any difficulty in distinguishing between the skulls, even of fœtal Gorillas and Chimpanzees. (Keith, 1899, p. 296.)

After critical examination of the entire literature we are of the opinion that hybridization has not been definitely established. However, specimens of ape occur which so closely resemble the generic types that it is difficult to classify them. This we accept as evidence of the intimacy of genetic relation between the genera.

Of other significant variations than the specific we have intentionally presented either suggestion or statement of fact by quotation from taxonomists, and we purpose now to comment briefly on the evidences and evaluate them in relation to psychobiological interests and needs.

The problem of variability is considerably complicated at the present time by the possibility of hybridization and the probability of dimorphism. If these should be established by further research the values of commonly accepted specific and varietal differences, such for example as coat color, skull and other skeletal measurements, nature of build and physical proportions, would be importantly modified.

Well established is the fact that profoundly important morphological changes occur not only during the period of growth but also between maturity and senility. They comprehend not only such seemingly unimportant modifications as alterations in pigmentation of hair and skin, but, as well, extreme changes in the musculature and skeleton. Well established also are profound morphological differences between the sexes and between individuals of the same sex. Indeed it is a fair question whether individual variations are not of equal importance with those which are commonly attributed to age, sex, species, or variety. Keith (1926, p. 490) maintains that the gorilla is even more highly variable than is man, and Schultz (1927, p. 36) is convinced that it is at least as variable.

Coat characters, of which certain taxonomists have made much, may very well turn out to be definitely related to age, sexual form and status, or to be dependent in part also on climatic and nutritional conditions. To evaluate or classify the variations of gorilla is at present impossible; discretion quite definitely demands careful inquiry into their relations to the essential phenomena of development, age, individuality, and sexual dimorphism. Possibly when the desirable morphological information is available, much of it will prove useful to the psychobiologist in that certain characteristics of behavior may be correlated with morphological conditions and ultimately accounted the functional expressions of such structures. Thus not only will problems of classification tend to find their solution in adequate knowledge of variations, but the solution of various psychobiological problems may also be facilitated.

DISTRIBUTION AND HABITAT

Current knowledge of gorilla distribution and habitat is both uncertain and incomplete, because the nature of the animal and its surroundings combine to render investi-

Fig. 127. The habitat of the mountain gorilla, showing a natural shelter. Courtesy M. Maxwell and Natural History Society of Bombay.

gation difficult. The gorilla is relatively silent, formidable, rare, and its habitat relatively difficult of human access and unfavorable to comfort and reliable observation, if not even to the maintenance of life. Until the end of the nineteenth century it was generally assumed that the ape occurred only in Equatorial West Africa, but with the discovery of the mountain forms its range was extended somewhat beyond the eastern border of the Belgian Congo.

The contrast between distributional information prior to the discovery of *Gorilla beringei* and that of today is strikingly exhibited by the following statements of Keith, the one published in 1896, and the other, thirty years later.

The gorilla is confined to the French and German territories north of the Congo: *see* Hartmann (1885), Savage (1847), Reade (1868), Reading (1884), Ford (1852), I. Geoffroy-St. Hilaire (1858-61), and Famelart (1883). The extent of its distribution eastwards is unknown. (Keith, 1896, p. 31.)

Thus the homeland of the gorilla extends across equatorial Africa from Nigeria in the West to Uganda in the East, a stretch of 1500 miles. But although the gorilla homeland is wide, its population is represented only by scattered and small family bands; from accounts furnished by travellers and hunters, one infers that the total population—males, females, and young—is well under 10,000. Spread over so wide a space one would expect to find well-differentiated local breeds or even species. There are only two breeds or races—the highland or Kivu race and the lowland or Gaboon race. The highlander lives on the brush and thickets which clothe the gullies and steep sides of his native mountains. The climate of his homeland, although on the equator, is wet, cloudy, and bleak; the Kivu gorilla lives at an altitude about 10,000 ft. above sea-level. (Keith, 1926, p. 490.)

In his introduction to Barns's *Wonderland of the Eastern Congo* Johnston sum-

marizes his discussion of the problem of distribution of the African anthropoid apes in a quotable paragraph which is as follows:

> The gorilla is distributed (apparently with intervening gaps) between the elevated Virunga volcano region on the east (almost on the frontiers of Western Uganda), and the coast region of the Gaboon and the Cameroons on the west. In the Cameroons, gorillas are found certainly as far north as the middle Sanagá River, and in a southerly direction their range extends into the Luango coast country, north of the Lower Congo. (Johnston, in Barns, 1922, p. xxvi.)

More recently Barns has himself gathered the substance of knowledge of species and distribution into a single sentence.

> There are three closely allied species of gorillas: two West African lowland species of the north Congo Forest, the Cameroons and the Gaboon (*Gorilla gorilla* and *Gorilla matschiei*), the third a highland eastern Congo form of north-west Tanganyika and the mountains and volcanoes of Kivu (*Gorilla beringei*). (Barns, 1923, p. 127.)

Suggested by the literature, but by no means definitely established, is the possibility that the distributional range of the gorilla was formerly greater than at present. It is stated that in 1851 and 1852 the animals were frequently observed on the coast of West Equatorial Africa (Garner, 1896, pp. 190-193). In our opinion this particular phenomenon is more likely indicative of migration in response to deficiency of food supply than of relatively permanent distributional change. Various authorities have offered evidence that the animals are irregularly distributed. The term insular has been suggested as applicable, since even apart from the well-established migrational phenomenon it appears that there are variable areas of concentration (Garner, 1896, pp. 188-194; von Oertzen, 1913, p. 5; Heck, 1922, p. 685; Derscheid, 1927; Coolidge, 1929?).

Concerning abundance or frequency little is known. Both early and late in the last century the relative rarity of the gorilla suggested to investigators its disappearance and probable extinction. From limited distribution, difficulty of negro hunters in procuring skins of adults, and the small number of captive specimens sent to Europe, Deniker (1891, pp. 369-370) infers that the process of extinction is under way. Likewise von Oertzen (1913, p. 4) thus warns of extinction and indicates the incompleteness of knowledge:

> This giant ape may apparently be exterminated before we have sufficiently learned to know him. Among the hunters and investigators who have personally killed gorillas, there is found scarcely one who can make such thorough observations of this animal that one may acquire a clear view of its manner of life. Skeletons have been measured, also many a skin has been prepared, but on the other hand the customs of life of the gorilla, its mental life, have not been well determined.
>
> How difficult observations on the anthropoids in freedom are, everyone understands who has only once traveled through the primitive forest. At every step a tricky liana winds around us, one's glance is hindered by an impenetrable wall of leaves.

Very similar is the plea of Akeley:

> And even less of study has been given the gorilla's living habits than has been devoted to his dead body and bones. Most of the information which man can get of and from this nearest relative in the animal kingdom is still to be had. But unless some measures are quickly taken to get this information, the opportunity will be lost. The gorilla is on his way to extinction. He is not particularly numerous. He is neither wary nor dangerous. He is an easy and highly prized prey to the "sporting" instinct. (Akeley, 1923, pp. 247-248.)

Undoubtedly it was these considerations which suggested to Akeley the desirability of rigid protection of gorillas, and in addition the establishment of an area which should serve at once as their breeding ground and as a place for study of their characteristics and mode of life.

Obviously a gorilla census is impracticable, if not impossible. For nearly a century it has been known that the gorilla is the rarest of the manlike apes. Few investigators have ventured to guess at the total number existent. Keith is an exception, and it is difficult to decide how seriously his estimate of 20,000 to 30,000 individuals (1914, p. 223) should be taken. But whereas there appears scant and entirely

Fig. 128. A recently vacated night shelter of a family of mountain gorillas. Courtesy of M. Maxwell and Natural History Society of Bombay.

inadequate basis for estimate of the present numbers of lowland gorillas, the situation is different in case of the mountain species because of its apparently more limited range. Nevertheless, even for it there is wide divergence of opinion, since Akeley estimates the number of *G. beringei* in the Birunga Mountains north of Lake Kivu as fifty to one hundred individuals (1923, p. 248), and Burbridge, writing five years later, says:

> In my estimate for the Belgian Government, I reported that there are about two thousand gorillas in the Kivu district, and I recommended that the present gorilla preserve be extended to include other mountain fastnesses, enlarging the gorilla sanctuary from two hundred and fifty to approximately five hundred square miles. There is now no threatened extinction of the gorilla in this section by white or native hunters. But there is a spotted menace, a potent factor too, in the leopard, who destroys numbers of young animals. (Burbridge, 1928, pp. 276-277.)

And, as result of the most careful survey known to us, Derscheid estimates the total number of mountain gorillas as six hundred to eight hundred and fifty (1927, pp. 156 ff.).

Whatever the total population of *G. beringei,* it is now definitely known that the range of distribution is much more extensive than Akeley suspected. Probably the species is correspondingly more abundant than he thought. Bradley notes, apropos of Akeley's inferences, that "it is quite possible that the range of this new gorilla territory is quite extensive. But the natives say that the gorillas are not numerous; they rove in bands, but there are not many bands, and the country itself is extremely difficult and dense, so though we heard them we did not catch a glimpse of them." (1926, pp. 206-207.)

The Annual Report of the Game Department of the Uganda Protectorate for 1925,

published in 1927,[1] estimates the number of mountain gorillas within the territory as one hundred, and states that in 1924 this animal was added to the Uganda list of completely protected species.

Although its distribution is peculiarly limited as to area it is diverse as to habitat, since the creatures are found from sea level to altitudes of nearly ten thousand feet, and consequently from the high temperatures of the lowland jungle to the low temperatures of the mountain forests. The gorilla is primarily a denizen of forest and jungle. That it must be highly adaptable to climatic conditions and to variations in food supply is indicated by the variations of habitat. The prevalent belief and related superstitions that it requires extremely high temperatures and can survive, as Garner puts it, only in "a low, humid region, reeking with miasma and the effluvia of decaying vegetation" where human life can hardly exist (1896, p. 263), are not supported by recent observations.

The surroundings of the lowland gorilla have been vividly pictured by von Oertzen, among others:

> Damp, moist, greenhouse temperature exists in the forests. Between mighty trees with their past of a thousand years stands an impenetrable underbrush. Giant trees thrown down either from age or by tornadoes rot on the ground. Creepers, thorns and thousands of plant parasites weave the whole into an impenetrable thicket. Rivers and streams flow through the forest. Every watercourse grows in the rainy time into a stream which spreads widely out of its bed and overwhelms the surroundings.
>
> A sad melancholy breathes from the landscape; only rarely does a laughing sunbeam break through the roof of leaves; no illuminating flowers bring color into the eternal twilight. Eight months of the year the rainy time lasts; there falls then that pitiless regular rain which obscures the sun for days and weeks, and which is only exchanged for a heavy fog.
>
> All life seems here to have perished; only here and there one hears the call of the great touracos, which amuse themselves with their dull drumming tones, or a cuckoo allows its sad scale to sound. The world of insects, however, is busy day and night. The ceaseless chirping of the grasshopper shrills in our ears. Greedy mosquitoes and sand fleas swarm about our bodies. We find ourselves in the native home of the anthropoids. (Von Oertzen, 1913, p. 3.)

In striking contrast with the habitat of the lowland gorilla is that of the mountain form as described by the hunters Barns and Burbridge:

> Gorillas are usually found in the thickest bamboo forest, but on the occasion of which I write I had driven them out of their usual haunts below camp, and they had, as I foresaw, taken to the open forest above me, taking refuge in the *kloofs* that run down from the peak of the Karisimbi Volcano. These are covered with an extraordinary tangle of succulent herbage, thigh deep with nettles, docks, sorrels, hemlocks, and blackberries, as well as larger growths of vernonias, balsams, lobelias, and senecios. Above this wonderland the magnificent pink-boled hagenia trees spread their fairy foliage, their low hanging branches thick with green moss-pads resembling great velvet cushions —veritable seats for the mighty, for young gorillas may sometimes be seen squatting on the lowest of them, or the older ones making use of the often hollow and bent trunks for their sleeping quarters. (Barns, 1923, pp. 139-140.)

> I have been on four hunting expeditions in Africa. This was my third, and the first in search of gorillas. As usual, I was the only white man in the party and I felt a veritable babe in the wood, for, despite my other experiences, it was all so unusual—these hobgoblin forests with aisles leading out into jungles of blackness beneath a canopy of clutching branches. Far below camp spread a vast amphitheater, glimpsed through the trees, a fairyland of beauty fading in the purpled distance. These foothills and mountain slopes, at chill altitudes of eleven to twelve thousand feet are clothed with dense vegetation because of the continuous tropical rains. The limbs of the great trees are festooned with flowering orchids, pale green mosses, and many blossoming vines and shrubs. And beneath is large-leafed succulent vegetation growing head high, of so soft and juicy a texture that a handful, if squeezed, would fill with liquid a small goblet.
>
> Broken in a veritable labyrinth of jungle-sown ravines and netted forests, it seemed nature had endowed these fastnesses with every care and forethought for the preservation of the gigantic ape. Half a dozen varieties of edible vegetables grow around beds of wild celery; the tender shoots from bamboo clusters prod upward from leafy floors; upon tree and shrub, berries are scattered through the endless miles of jungle stronghold.

[1] Annual report of the Game Department of the Uganda Protectorate for the year ended 31st December, 1925. 1927. Pp. 68. Entebbe (Government printer, Uganda).

Mother Nature, while kindly to the gorilla, did not fail to lift a protecting hand to throw every obstacle of entanglement and barricade against man's intrusion into these solitudes. For some reason, ominous it may be, elephants, lions, and other killers rarely invade the forests of the gorilla. The crafty leopard alone left here and there in the gorilla's trail the occasional traces of his spoor. (Burbridge, 1928, pp. 215-216.)

Probably the best description of the habitat of *G. beringei* is that of Maxwell (1928, pp. 436 ff.). We are privileged to reproduce some of his splendid illustrations.

CHAPTER THIRTY-TWO

MODE OF LIFE, LOCOMOTION, AND HANDEDNESS OF GORILLA

OF the manlike apes the gorilla is relatively large, powerful, shy, wary, and slow moving. It is also predominantly terrestrial, gregarious, nomadic, and herbivorous. Into a sentence or two much may thus be crowded, but if the reader is to be enriched informationally each term must be defined, qualified, and illuminated by illustrative observations.

Although the gorilla may exist only in a single species, its mode of life varies appreciably with local races or varieties, sex and developmental status, and still more, possibly, with those important variations in conditions of life associated with freedom and captivity. Assuredly great caution must be exercised in attributing to the free wild gorilla behavior which is observed in captives, for the latter are commonly stunted by malnutrition and rendered abnormal by disease and other forms of physical disability.

Until the present century scant information concerning mode of life was available. General descriptions were few and those brief and obviously inadequate. We cite the 1847 paper of Savage and Wyman as of continuing interest historically, although clearly based in considerable measure upon the statements of natives. Du Chaillu in 1861 contributed a work which still stands as illuminating, despite its highly colored and exaggerated descriptions. The publications of Hartmann possess relatively little naturalistic value, although they may be excellent morphologically. It remained for Reichenow in 1920 to present the best historical and original description of the gorilla's behavioral characteristics and environmental relations. His paper is of such outstanding importance that it should be read by every student of the life of the gorilla. Finally, in Brehm's *Tierleben* (1922) Heck has presented a readable and reasonably reliable description of manner of life.

Instead of a brief general description of what not long since would have been labeled instincts and habits, we purpose to offer in this volume description, with citation of major authorities and sources, of such obviously important aspects of mode of life as locomotion, nesting, sleeping, feeding, cleanliness, and diseases and disabilities.

It is natural and logically defensible to seek first impressions of the characteristics of the gorilla and of its environmental relations and habits of life from the experiences of those who have hunted and captured it. The opinion, long prevalent and still common, that this great ape is aggressively savage, ferocious, and extremely dangerous to man, finds early basis in the description of Savage and Wyman:

> They are exceedingly ferocious, and always offensive in their habits, never running from man as does the Chimpanzée. They are objects of terror to the natives, and are never encountered by them except on the defensive. The few that have been captured were killed by elephant hunters and native traders as they came suddenly upon them while passing through the forests.
>
> It is said that when the male is first seen he gives a terrific yell that resounds far and wide through the forest, something like *kh-ah! kh-ah!* prolonged and shrill. His enormous jaws are widely opened at each expiration, his under lip hangs over the chin, and the hairy ridge and scalp is contracted upon the brow, presenting an aspect of indescribable ferocity. The females and young at the first cry quickly disappear; he then approaches the enemy in great fury, pouring out his horrid cries in quick succession. The hunter awaits his approach with his gun extended; if his aim is not sure he permits the animal to grasp the barrel, and as he carries it to his mouth (which is his habit) he fires; should the gun fail to go off, the barrel (that of an ordinary musket, which is thin) is crushed between his teeth, and the encounter soon proves fatal to the hunter. (1847, p. 424.)

From 1847 until the publication of Du Chaillu's famous work in 1861 the statements of Savage and Wyman, although obviously based chiefly on the reports of natives, were repeated in the literature without verification. And, as it happened, the great exploiter of the gorilla attributed to it even greater ferocity and terrors for man than had his predecessors. As the effect of his narrative and description would be lost in paraphrase, we quote signal paragraphs.

Looking once more to our guns, we started off. I confess that I never was more excited in my life. For years I had heard of the terrible roar of the gorilla, of its vast strength, its fierce courage, if, unhappily, only wounded by a shot. I knew that we were about to pit ourselves against an animal which even the leopard of these mountains fears, and which, perhaps, has driven the lion out of this territory; for the king of beasts, so numerous elsewhere in Africa, is never met in the land of the gorilla. Thus it was with no little emotion that I now turned again toward the prize at which I had been hoping for years to get a shot. (Du Chaillu, 1861, p. 59.)

Suddenly, as we were yet creeping along, in a silence which made a heavy breath seem loud and distinct, the woods were at once filled with the tremendous barking roar of the gorilla.

Then the underbrush swayed rapidly just ahead, and presently before us stood an immense male gorilla. He had gone through the jungle on his all-fours; but when he saw our party he erected himself and looked us boldly in the face. He stood about a dozen yards from us, and was a sight I think I shall never forget. Nearly six feet high (he proved four inches shorter), with immense body, huge chest, and great muscular arms, with fiercely-glaring large deep gray eyes, and a hellish expression of face, which seemed to me like some nightmare vision: thus stood before us this king of the African forest. (P. 70.)

His eyes began to flash fiercer fire as we stood motionless on the defensive, and the crest of short hair which stands on his forehead began to twitch rapidly up and down, while his powerful fangs were shown as he again sent forth a thunderous roar. And now truly he reminded me of nothing but some hellish dream creature—a being of that hideous order, half-man half-beast, which we find pictured by old artists in some representations of the infernal regions. He advanced a few steps—then stopped to utter that hideous roar again—advanced again, and finally stopped when at a distance of about six yards from us. And here, just as he began another of his roars, beating his breast in rage, we fired, and killed him. (P. 71.)

It is worth noting that this author's descriptions are seriously affected by overemphasis and interpretation. Had he been content to give a simple direct statement of fact instead of a highly colored and exciting narrative of adventurous observation, his work undoubtedly would have been accepted enthusiastically by the scientific world as well as by the laity.

There can be no doubt that the great strength and the nature of the habitat and habits of the gorilla render its capture difficult and hazardous. Nevertheless in recent years, as we shall presently prove by citation, opinion concerning ferocity has radically altered. Thus von Koppenfels (1877, p. 418) asserts of the lowland gorilla that as long as he is undisturbed he does not attack man but instead avoids him. And having described the behavior of an individual when surprised by man, he continues: "If one does not annoy him and withdraws in good season before his anger reaches its high point, I believe that he would never attack." Despite this assurance, the descriptive phrases of von Koppenfels are so similar to those of Du Chaillu that they do not encourage careless approach or neglect of defensive precautions on the part of the hunter. Likewise, von Oertzen (1913, p. 6), an excellent observer, substantially confirms the impression of von Koppenfels, for he reports that the animals appear to be shy and fearful of man and tend to seek safety in flight. But he also reports instances of attacks on natives. By far the most valuable discussion of the attitude of the gorilla toward man is that of Reichenow (1920, pp. 32 ff.). We gather from the reports of this author's observations and his analysis of the literature that the animal is characteristically shy, cautious, and as a rule endeavors to avoid man. Evidences of aggressiveness and of ferocity appear only when males are cornered, wounded, or aroused to the defense of females and young. The following brief quotation at once substantiates this general statement and indicates the attitude of the Negro, which probably served as basis for

the opinions expressed by Savage and Wyman and also Du Chaillu.

When the gorilla notices the approach of human beings, he gives a short bellow, usually twice, which makes the females and young ones attentive, for they draw back toward the other side. At the same time the bellow apparently means a warning for the one who is approaching, for the gorilla himself remains quietly in his place. Experience has taught him that this bellow is sufficient as a rule to cause human beings rapidly to retreat. If one goes forward further he yields a couple of meters, while bellowing still more strongly. If one approaches still more one hears repeated bellows and clapping and beating noises. . . .

The clapping and drumming announce, according to the statements of the natives, the approaching attack of the gorilla. Du Chaillu also reports the same as his own experience. I have, however, in no case seen an immediate attack, that is, in the sense that the gorilla would suddenly run toward me. The animal rather breaks into flight when I again approach nearer, with continuous roaring.

The flight does not go far, since the gorilla maintains with a certain stubbornness his place once chosen for breakfast, and apparently on account of certain mental sluggishness he does not love sudden changes of program. He halts at a distance of 100 to 200 meters, where he repeats the same performance.

From the native one hears always the same stories which appear in the accounts of the earlier travelers: If a black man with his bush weapon comes into the neighborhood of the gorilla, the ape runs toward him, breaks his weapon and kills him. To my question why the gorilla should then run away from me, the answer is that the "Ngi knows that the white man has a better weapon and therefore fears him more." In fact, only the unaccustomed aspect of the white man appears to put the gorilla to flight. (Reichenow, 1920, pp. 32-33.)

An excellent account of the gorilla as hunted appears in Heck (1922, pp. 682 ff.). From this, as well as from the statements of such excellent observers as von Koppenfels, von Oertzen, and Reichenow, we gather that, although not by nature aggressively savage or ferocious, the lowland varieties of gorilla are nevertheless extremely formidable and dangerous antagonists of man. Their behavior varies so greatly with individuals and circumstances that the observer or hunter should always be prepared to defend himself.

On turning to the consideration of the characteristics of the mountain varieties of gorilla we immediately discover that the hunters and naturalistic observers Barns, Akeley, Prince William of Sweden, Gyldenstolpe, Bradley, Burbridge, and Maxwell, substantially agree in describing the creature as neither aggressively savage nor particularly dangerous to man. Akeley, convinced that gorilla characteristics had been grossly misrepresented by many of the writers of the nineteenth century, and especially by the reported opinions of the natives and by Du Chaillu, thus expresses his opinion, subsequently supported by direct observation, in what he calls his creed concerning the gorilla.

I believe that the gorilla is normally a perfectly amiable and decent creature. I believe that if he attacks man it is because he is being attacked or thinks that he is being attacked. I believe that he will fight in self-defense and probably in defense of his family; that he will keep away from a fight until he is frightened or driven into it. I believe that, although the old male advances when a hunter is approaching a family of gorillas, he will not close in, if the man involved has the courage to stand firm. In other words, his advance will turn out to be what is usually called a bluff.

I believe, however, that the white man who will allow a gorilla to get within ten feet of him without shooting is a plain darn fool, for certainly the average man would have little show in the clutch of a three or four hundred pound gorilla.

My faith in the general amiability and decency of the gorilla is not based on experience or actual knowledge of any sort, but on deductions from the observation of wild animals in general and more particularly of monkeys. There are few animals that deliberately go into fight with an unknown antagonist or with a known antagonist, for that matter, without what seems to them a good reason. In other words, they are not looking for trouble.

The lion will fight when the maintenance of his dignity demands it. Most animals will fight only when driven to it through fear, either for themselves or their young. (1923, p. 196.)

During his hunting and collecting expeditions in the Lake Kivu region of the Belgian Congo Akeley saw no evidences of the gorilla's aggressive ferocity, and in recounting his experience with an old male he remarks: "Of the two I was the savage and the ag-

Fig. 129. An adult mountain gorilla, *G. beringei,* mounted by Carl Akeley. Courtesy of the American Museum of Natural History.

gressor" (p. 216). Aside from shooting certain specimens of *Gorilla beringei* for a group in the American Museum of Natural History, New York, it was Akeley's good fortune to secure the first motion-picture records of the wild mountain gorilla in the freedom of its native forests.

Wholly confirmatory of Akeley's observa-

tions and opinions are those of the hunter Barns, who of *G. beringei* writes:

> They are so very human and interesting, the young ones so unsuspicious of danger, the older ones so full of curiosity, that hunting them can hardly be called sport. Owing, however, to the native tales one hears of their ferocity, and even carnivorous habits, the tyro approaches them with caution, his imagination alight at the thought that they will attack him on the slightest provocation. Adding to this the undoubted menacing look of the older animals, their gigantic size and strength, the hunter is perhaps to be pardoned if he exaggerates the danger their chase entails. Truth to tell, however, he is in more danger when crossing a London "death trap" or taking a ride in an aeroplane. The gorilla is a great bluffer, and if he can't frighten you away by his uncanny screaming roars or by the beating of his great chest, he leaves it at that—he is certainly not looking for trouble. (1923, p. 135.)

Although Barns remarks that the mountain gorilla is not very dangerous the relativity of the statement should not be overlooked, for assuredly the naturalistic observer or hunter who assumes that the animal under no circumstances will attack is pitifully stupid. We suspect that Burbridge comes near to the heart of the matter when he attributes to individual and temperamental differences and variations the apparently contradictory reports concerning the attitude of the hunted gorilla which are found in the literature. Referring defensively to the contribution of Du Chaillu, Burbridge writes:

> Some present-day naturalists have gone even further in burning up the ears of the little Frenchman. While the roaring and the chest-beating are accepted, the gorilla by them is described as more or less harmless unless driven to attack in self-defense.
>
> Such a different review of the gorilla's behavior would seem strange were it not that casual observations have small value when the temperamental variations and individuality of gorillas are considered. The animals are remarkably individualized, and facts as well as inconsistencies of behavior appear to defy standardization.
>
> Lions, elephants, buffaloes, and rhinos, recognized as capital killers, have an instinctive fear of man. The lower races of men fear the higher. Perhaps the gorilla stands somewhere between. None knows just where instinct ends and reason begins, or what psychological conditions prompt discretion or aggression in the moments of his wrath. In the lone savage the gorilla may instinctively perceive a ready victim, whereas the white man and his attendants, armed with thunder and lead, may look no safer to him than did a handful of Spaniards to the Aztec horde hundreds of years ago. (1928, pp. 207-208.)

By reason of persistence and patiently intelligent observation of the characteristics and manner of life of the mountain gorilla, Burbridge succeeded in obtaining some splendid motion-picture records of the wild animals, and, in addition, captured alive at various times eight immature specimens, of which two were delivered by him to the Zoölogical Garden in Antwerp, and one, the female specimen later referred to in this work as Congo, was brought to America and for more than two years kept in Florida. Burbridge, both in photographing and capturing gorillas, played upon timidity, curiosity, and parental solicitude. The following vivid description of the capture of a young one exhibits method and action.

> We could hear the gorillas moving in the forest a hundred feet distant. A snarl and a scream from Joe and Mugualla, and the leopard decoy signal had been given. As the men changed their position, running noiselessly to where I crouched, with a crashing rush a mob of stalwart females broke from the shadows to the right with a half dozen young at their heels. They had reached the edge of the canyon. It was the crucial moment and I forced myself to act. Firing my pistols, I tore through the forest toward them, with my two men following. Gorillas ran screaming; several went over the side of the chasm. I followed, rolling over and over. A stunning blow upon my head added a starry firmament as I splashed down into water and vegetation, grasping the while a screaming black ball of fur which scrambled ahead of me. We grappled. I had him under my full weight. Mugualla threw himself upon us both. He came down like a catapult. The young gorilla slipped from under. We covered him again. He fought with feet and hands, scratching and biting. He was fast, at least three grabs ahead of us, and his sixty pounds of muscular strength was superhuman. But we worked a sack over his head. Then the hubbub was augmented by the boom-boom-boom of Joe's rifle. We got the gorilla into the sack at last and drew the string secure. (1928, pp. 247-248.)

For upward of a century gorillas have from time to time been taken alive and occasionally carried to Europe or America.

Most of the specimens have been very young and few have long survived in captivity. The common method of capture by both negroes and whites has been the scattering of the surprised band or family, the terrifying or destruction of parents or other adult members of the group, and the taking of infantile or partially grown specimens by hand or in nets (von Oertzen, 1913, p. 10). Most frequently reported, since the use of firearms became common, is the shooting of the mother and the subsequent capture alive of a nursing infant or a semi-dependent youngster. As far as we have been able to discover, the method of Burbridge is unique; so also is his success, not only in capturing specimens without injury but in transporting them to Europe or America in healthful condition.

Many authorities have stated that the capture of adult or well-grown gorillas uninjured is practically impossible, and the records certainly indicate that it is rare. The following account by Zell (1908, pp. 376-377) of a successful hunt is of peculiar interest and importance. It reads:

> Capt. Dominik, of the German army, has performed a feat which was regarded as impossible by taking alive and unharmed three gorillas, of which two were fully grown and the third nearly so.
>
> . . . .
>
> He succeeded, therefore, in engaging nearly a thousand blacks. By dint of shooting, shouting, and beating on hollow trees the gorillas were driven in panic from the rocky defiles of Mt. Launde to a forest glade where they were surrounded and penned in with strong nets. The drive occupied two days. At night, fires were lighted around the inclosure and any gorilla that attempted flight was driven back by shouting and hurling fire brands. In the evening of the second day the hungry apes made a combined effort to scale the nets and escape. Two were shot and the others were driven back. It was a moonlight night and Dominik determined to attempt the capture, with the aid of twenty picked men and a number of dogs. Several gorillas were shot, two big males escaped, but three nearly full grown apes were captured by throwing nets over them and holding them down with long forked poles, while they were fighting with the fierce native dogs.

For the hundreds of gorillas which have been taken alive and kept for a few weeks, or in exceptional cases for several months, in Africa, Europe, or America, science has little indeed to show. The thousands of specimens which have been shot by hunter-collectors or sacrificed to the untoward conditions of captivity have yielded much to morphology, and the museums of the world are well stocked with exhibition specimens and skins and skeletal materials for taxonomic research. But from all the facts available it appears that the wastage of gorilla life and failure to utilize opportunities for study of mode of life and behavior, are conspicuous, characteristic, and inexcusable.

LOCOMOTION AND HANDEDNESS

The literature clearly indicates the terrestrial habit of the gorilla. Probably the mountain varieties frequent trees less than do the lowland forms. The evidence is overwhelming that the animal is most at home upon the ground. In walking it places the feet flat upon the ground and with the body bent forward rests a part of its weight on the hands, which instead of being placed flat on the ground, as are the feet, are closed so that the knuckles are in contact with the ground. There are, as in the case of most other mammals, several varieties of gait. That of the gorilla may resemble the customary gait of the dog, or it may on occasion rest the body weight on the hands and swing the body forward so that the legs come between the arms.

Of the *G. beringei*, Maxwell (1928, p. 447) writes:

> Their accelerated mode of progression, or run on all fours, resolves itself into the following impacts, namely: right knuckles—left knuckles—margin of right foot pad—margin of left foot pad. In fact, the impacts themselves succeed one another in much the same way as in the canter of a four-footed animal, i.e., a transverse motion. . . . The forward progression of the body, in the run, is accompanied by a slight side swing, an almost imperceptible side twist, of the animal's hind quarters.

This peculiarity of gait we have observed in the young chimpanzee, but never in the young gorilla.

Our own observations indicate that even

Fig. 130. Profile of a full-grown male mountain gorilla, mounted by Carl Akeley. Courtesy of the American Museum of Natural History.

at its most rapid rate of walking or running the young gorilla may readily be overtaken on clear ground by a man. In this it differs strikingly from the chimpanzee, which is capable of much more rapid locomotion. Assuredly the gorilla is capable of standing erect with feet flat upon the ground. It frequently does so when feeding or when investigating its surroundings. But ordinarily it grasps with its hands any supporting growth or structure which may be at hand. Rarely does it walk voluntarily more than a few steps standing erect and without aid of its arms, for evidently this mode of locomotion, although possible, is relatively difficult and unnatural. Variations in locomotion should be especially emphasized, for, as in man, peculiarities or vagaries of locomotion are characteristic of individuality and stages of development. No single and simple description is universally applicable or adequate. At best it is possible within brief compass only to indicate conspicuous features and to describe what appears to be the typical procedure.

There are, it is true, discrepancies and conflicting statements in the literature. Thus, for example, Ford (1852-53, p. 32),

in a paper which contains several obvious inaccuracies, tells us that the animal in walking may place its open hands on the ground. Hartmann (1885, p. 231) confirms this observation by saying that the hands are rarely thus used. In the several specimens observed by us this placement of the hand has never been noted. Those who desire to consult sources will find in Du Chaillu (1861) the best early description of locomotion. His observations are scattered throughout his volume and are unsatisfactory indeed by comparison with more recent statements. The locomotion of a captive specimen is described by Carpenter (1917), and more general descriptions appear in Reichenow (1920), Akeley (1923), Barns (1923), Keith (1926), and Maxwell (1928). With approval, we present the following statement of fact and opinion by Keith:

> Both Lamarck (1809) and Darwin (1871) supposed that if an anthropoid ape became, either from choice or necessity, a ground-living form it would, in the course of generations, acquire a human gait. A little reflection will convince anyone that an animal weighing 30 st., such as the male gorilla, must be a clumsy climber; its flight would be limited to such trees and branches as could carry so great a weight. Mere weight compels the adult male to a life on the ground. From the accounts which have come home from hunters and travellers we now know that gorillas are, particularly the adult males, ground-living forms, and apparently have been such for many a generation. Yet the gorilla still walks with a forward slant in his body, supporting and balancing his weight on his bent knuckles as he advances. His feet, it is true, have advanced nearer to a human shape than those of any other known ape. (1926, p. 490.)

It is the opinion of Garner (1896, pp. 207-208) that the gorilla can stand upon his feet alone, and walk a few steps in that position, but this he does only when undisturbed and even then he usually holds to something with his hands. In its customary sitting posture, the gorilla, according to Garner, "rests his body upon the ischial bones, with his legs extended or crossed, while the chimpanzee usually squats, resting those bones upon his heels."

We may sum up these paragraphs with the statement that the gorilla usually walks much as do various other quadrupeds, except for the peculiar placement and use of its hands. It is neither bipedal in its locomotion nor is it to any considerable extent arboreal in its habit of life. Concerning the last item of fact, namely, arborealness, evidence is essential.

There can be no doubt that the various races or species of gorilla are capable of tree climbing. Probably the lowland forms are more skilful in this, and naturally therefore more given to it, than are the mountain varieties. It is commonly observed that captive specimens, if in good health, climb freely and with at least as much skill as the average boy or man. It is remarked by Garner (1896, p. 206) that although expert climbers, the animals are unable to sleep in a tree because the feet are incapable of grasping limbs as do those of most monkeys, the chimpanzee, and orang-outan. So also Maxwell (1928, pp. 444-445) for the mountain gorilla, and Reichenow (1920, pp. 20-21) for the lowland varieties, while affirming tree-climbing ability, emphasize its limitation by contrast with that of the other manlike apes and characterize the activity as relatively slow and cautious instead of free. On occasion the gorilla may ascend to the very tops of tall trees, but in so doing it is said to proceed cautiously, testing limbs as it goes, to make sure that they will bear its weight. By contrast, the chimpanzee dashes along, trusting to its acrobatic skill to save it from harm in case a limb breaks or it misses or loses its grasp of a support.

Notable also is the fact that this great ape is not given to jumping, either from the ground or from elevations at which it may be supported. Occasionally report is made of an animal leaping or crashing from a tree to the ground, but always it appears to be from necessity rather than choice. Hunted animals are observed to act thus, but rarely has it been reported that captives freely indulge in acrobatic activities, either in amusing themselves or in attempting to reach objects. This again is in marked contrast with the behavior of the chimpanzee.

In months of almost continuous observation of the mountain gorilla Congo we very rarely saw even incipient tendency to jump. Obviously the differences in physique between gorilla and chimpanzee are no more conspicuous than are the differences in locomotor tendency, ability, and skill.

It is often asserted that in the structure and use of its feet and hands the gorilla is the most manlike of existing primates. The statement might seem to imply that the animal also most closely approaches us in locomotion, but this can scarcely have been intended, for the chimpanzee appears to walk erect, with feet flat upon the ground, more willingly and readily than either gorilla or orang-outan. In its terrestrial habit the gorilla, however, is more nearly akin to man.

Whereas in the chimpanzee there are varied evidences of interest in rhythmic stimuli or activities, the opposite holds of the gorilla. We have discovered only a few references to dance-like movements or other indications of partiality for rhythm. Of a young captive for a considerable time under his care, Falkenstein (1879, p. 152) reports spontaneous and untaught handclapping and whirling about in a crude dance as if "drunk with pleasure." These activities appeared when the animal was in perfect health and apparently exceptionally energetic. So also von Oertzen (1913, p. 12) reports of a captive female that without being taught she readily learned to walk on her hind legs and to perform a kind of dance seemingly "borrowed from the negroes." There is, of course, rhythmic beating of the chest and of surrounding objects, but aside from such activities we have no additional evidence of the invention of dances or indulgence in anything akin to dance movements by the gorilla.

It has been indicated that this ape is more at home on the ground than above it. So likewise it appears to be averse to trusting itself to water. Direct observations are few and in a measure contradictory. We present typical examples.

Fondness for water as a medium for play has been reported in several captive specimens, notably by Falkenstein (1879, p. 153); and ready adaptation to bathing in warm water has also been observed, as for example by Cunningham (1921, p. 123). It is thus indicated that the animal has no strong aversion to water. Garner (1896, p. 189) asserts dislike of deep water on its part, considers doubtful its ability to swim, yet finds in the characteristic webbing of the digits a puzzling suggestion of natatorial ability. "I have been told," he adds, "that the gorilla can swim, and it may be true; but I have never observed anything in his habits to confirm this, while I have noted many facts that controvert it."

Another variety of evidence is drawn from distribution, which commonly is asserted to be insular and definitely related to water boundaries. We take the following expository and critical comment from Elliot (1913, III, 211), who, in reviewing a paper by Rothschild (1906) relative to gorilla races, remarks:

> In order to account for these races of Gorilla being found in Cameroon the Author supposes they cannot swim and therefore the races are separated and entirely isolated by the large rivers. This is a view taken from Selenka, in defense of his creating various species of Ourang, but, as in Selenka's case, no proof whatever, either of the Gorilla's lack of ability to swim or of its confinement to certain districts is forthcoming, and it may be considered exceedingly doubtful if this Ape is restricted in its wandering "as if on islands," for the "dry seasons" in tropical lands reduce the volume of water in the rivers to such a degree as to disclose their beds in many places, even sometimes of the largest streams, thus affording an easy passage from one bank to the other.

More obviously and directly to the point is the following report by Reichenow:

> In following the numerous trails I have never observed that the deep streams which the animals would have to swim had been crossed. The course of the Njong seems to me always to be the boundary of the range. But that rivers are not impassable obstacles for the gorilla Oertzen asserts:
>
> "That the ape does not under all conditions avoid water, I have undoubtedly established with the gorilla. From the prints one can easily see that a herd of eight head had swum across the Ayne river which in that place was sixty meters broad." (Reichenow, 1920, p. 30.)

Granting the inconclusiveness of the evidences available we venture the tentative inference therefrom that the gorilla possesses neither fondness for water as surrounding medium nor natural ability to swim. In these respects we have discovered no reason to suppose that it differs essentially from man, orang-outan, or chimpanzee. Whether like man the great apes can readily learn of their own initiative or be taught to swim we do not know.

The widespread and intense human interest in handedness would justify expectation of numerous records of evidence of such tendency or the lack of it in the gorilla, but the literature indicates otherwise. Indeed, there is almost complete lack of recorded observations. What we have succeeded in discovering we herewith report.

On the assumption that the larger and presumably the stronger limb or side of the bilaterally symmetrical organism is dominant in activity and probably also preferred for various acts, Mollison (1908, pp. 112-115), from various skeletal measurements, states that gibbon, orang-outan, and man are naturally right-handed, gorilla and chimpanzee left-handed. From a more recent paper by the same authority, a continuation of his study of the functional significance of asymmetry, we quote a few sentences which are immediately relevant.

> In the arm the right side is greatly preferred in the gibbon, orang, and man, the left, at least in the lower arm and also less plainly (there is more frequent equality) in the chimpanzee and gorilla. All three bones of the leg predominate easily on the right side in the orang and gibbon, on the left in the gorilla. (Mollison, 1910-11, p. 196.)

The author thus summarizes important conclusions:

> The proportions of each primate show a dependence on two factors: function and species relationship.
>
> Primarily, proportions are dependent on the kind of locomotion. We can distinguish for it five types: springer, climber, runner, hanger, and walker. To each of these types of locomotion corresponds a certain type of proportion. (Pp. 248-249.)

Instead of presuming to discuss or attempt to evaluate the facts, assumptions, and arguments of Mollison we shall present the remainder of our evidences. Of handedness in the lowland captive John Daniel, who for some years was kept by Alyse Cunningham in London, Fick (1926, p. 432) thus writes:

> I will mention here what Major Penny told me at my request, that the gorilla may be exclusively a right-hander; for example, both in eating and in throwing sand or stones, which he likes to do, as I myself observed. Major Penny has never seen him carry out these movements with his left hand.

The author continues with the following related information:

> Mollison calls the orang the greatest right-hander after man, the chimpanzee and gorilla left-handers. With the chimpanzees from Tenerife and the other chimpanzees in the Zoölogical Garden in Berlin I found no *lasting* preference for one hand in grasping. Here and there I believed I had established in one or another an exclusive use of the right hand, and then a grasping with the left hand would throw this idea over. I should designate the chimpanzees as "both handers" (ambidextrous).

The sole record of experimental test of handedness in the gorilla is that of Yerkes for the approximately five-year-old specimen of *G. beringei,* Congo. The subject was tested under definitely described conditions for maximal arm and leg reach and preference of side in reaching or in using objects as tools. Right-handedness was repeatedly observed and in conjunction therewith left-footedness. The author states (1927, pp. 69-72):

> Right-handedness was early manifested in the various forms of stick problem, and by a systematic test in which the gorilla was made to reach for food I discovered that she used the right hand and arm approximately two-thirds of the time. (Pp. 69-70.)
>
> I set the problem in six different locations and despite the variation of conditions Congo consistently reached with her right arm and hand, if the object was near, and with her left leg and foot, if the object was beyond arm reach. These confirmatory observations are mentioned because of the unexpectedness of the marked preference and its possible significance in connection with further investigation of handedness, footedness, and eyedness in relation to neurological conditions. (Pp. 71-72.)

We have discovered no other records of observations and we note simply that whereas the behavioral reports for the lowland gorilla John Daniel and the mountain gorilla Congo agree in indicating right-handedness, they are contradictory of Mollison's inference from physical measurements that the gorilla should naturally be left-handed.

We conclude this section with the tentative generalization that the gorilla is a heavily built, clumsy, and slow-moving primate, of terrestrial habit, which, although ordinarily quadrupedal in its locomotion, strikingly resembles man in the structural characters of its extremities, and, like man, is a fairly skilful although cautious climber, but by preference non-arboreal. Apparently it resembles man also in natural fear and avoidance of deep water, inability to swim without tuition or practice, and preferential use of the right hand.

CHAPTER THIRTY-THREE

NESTING AND FEEDING ACTIVITIES IN GORILLA

BECAUSE nest-building activities result in visible modifications of environment which the naturalist may study at his leisure, the literature on this aspect of the gorilla's "mode of life" is relatively abundant and knowledge correspondingly varied. The progress of enlightenment, with its perplexingly contradictory findings and persistent uncertainties, may best be exhibited by a chronological survey.

> Their dwellings, if they may be so called, are similar to those of the Chimpanzée, consisting simply of a few sticks and leafy branches supported by the crotches and limbs of trees; they afford no shelter, and are occupied only at night. (Savage and Wyman, 1847, p. 424.)

Thus Savage and Wyman, primarily, it would appear, on the basis of native report, prepared the mold for opinion and supposition concerning this topic. That they were partially right will presently appear. It is important to remark that they drew their facts from the Gaboon region.

During the next quarter century there is scant evidence of progress. The rumor seems to have become current that hut-like roofed nests were constructed by gorilla, chimpanzee, or both, for in 1849 Gautier-Laboullay (1858-61, p. 89) wrote that the gorilla lives in trees and in rainy weather sleeps in roofless nests. And lack of protection from rain is remarked also by I. Geoffroy-Saint-Hilaire (1858-61, p. 54), who, in addition to emphasizing uncertainty of knowledge concerning nest building, says that the gorilla differs markedly from the chimpanzee, the structures of the latter being placed much higher in trees and more carefully woven.

According to Du Chaillu (1861, p. 349) young gorillas, and possibly also females with nursing infants, sometimes rest and sleep in trees, whereas the male takes his position at the foot of the tree with his back against the trunk. Evidently the first-hand information of this writer was meager and he gleaned little from the statements of the Negroes. Reade (1864) and Owen (1865) present the fact of nest building without critical discussion, but in Falkenstein (1879, p. 153) appears the significant statement that the animals certainly remain on the ground at night in a resting place prepared by raking together leaves and twigs. In effect the essential observations of Du Chaillu are confirmed by von Koppenfels (1877, p. 418), who reports that the animals each evening build nests in small trees at a height of five to six meters. They are like the nests of the stork and consist of green branches placed in the first strong forking limbs. The young animals, if they still require the warmth and protection of the mother, seek shelter with her in such a nest, "while the father crouches at the foot of the tree, with his back against it, to spend the night and to protect his family from the attacks of leopards."

Despite all that had previously been published, Garner in 1896 (p. 217) writes:

> It has been said by many that the gorilla builds a rude hut or shelter for himself and family, but I have found no evidence that such is true. The natives declare that he does so, and some white men affirm the same; but during my travels through their habitat, I offered liberal and frequent rewards to any native who would show me one of these specimens of simian architecture, but I was never able to find any trace of one made or occupied by any ape.

Subsequently this author substituted for his denial of nest building the assertion that the mother gorilla "makes the bed for herself and her baby about twenty feet above the ground in much the same way as the chimpanzee. But the father gorilla makes his bed on the ground itself." (1919, p. 401.) This description, like that of von

Fig. 131. The bed or nest of a mountain gorilla in the crotch of a tree on Mt. Karisimbi, at an altitude of about 11,000 feet. Courtesy of M. Maxwell and Natural History Society of Bombay.

Koppenfels, suggests the influence of Du Chaillu and leaves us uncertain as to the facts. Garner's remark about the testimony of the African natives is further substantiated and its value magnified by an abstract of native testimony taken from Jenks (1911, p. 57): "The gorilla seldom, if ever, sleeps two successive nights in the same place."

The common sleeping posture is said to be on side or back, with the head pillowed on one or both arms. But undoubtedly this is extremely variable, for certain authorities report the sitting or recumbent attitude in addition to or instead of the side or back positions. Forbes (1894, II, 187) and Garner (1896, p. 228) refer especially to the recumbent attitude, and Bates (1905, p. 68) to the sitting posture. The last named author mentions also report of snoring, but of this we have discovered no other record. Our own observations of a half-grown mountain gorilla confirm the side and back positions as typical, and further indicate that, although the animal would not ordinarily seek materials for nest construction, she would crudely fashion a nest out of straw provided and either burrow into it or, if the temperature was unusually low, draw the straw over her.

In further comment on the nest-building activities of captive specimens the discussion of Sokolowsky (1908, p. 38) should be cited, for he emphatically asserts the existence of an instinct for nest building and reports that young captives will on occasion, if supplied with suitable materials, sit in the midst of them and with evident intent and seriousness of purpose, markedly distinguished from play, shape them into the form of a nest or bed. Since this author does not disprove the existence of imitation

or tuition, the use of the word instinct evidently is unjustified, and we can with assurance assert that although both young and adult gorillas have nest-building tendency and ability, there is complete lack of knowledge as to whether it is innate, acquired, or in part each.

A step forward is marked by the original contribution of von Oertzen which, although brief, is definite, circumstantial, and convincing.

> In the Ayne swamps near Akoafim, I had frequently hunted gorillas in vain, until one morning I came on an old deserted farm, the recently abandoned camp of a herd. I counted sixteen sleeping nests, nine of which were found upon the ground, seven in branches of umbrella trees at a height of about three to five meters. The nests were transparent and relatively small. If one cannot determine unconditionally the number of heads in the herd from the number of nests, since one or another animal may build several nests until it comes to rest, yet it may be assumed that in this case at least ten animals were found together, a number which certainly exceeds the limits of a family. Also a native hunter in North and South Kamerun assured me that the gorilla, like the chimpanzee, lives in herds. A view many times asserted that the gorilla lives only in families, appears not to hold in all regions. (1913, p. 4.)

Incomparably the most useful discussion of gorilla nesting and sleeping is that of Reichenow (1920, pp. 5 ff.), for in addition to reviewing briefly previous contributions, this investigator records considerable new information. The discussion is throughout comparative, as is indicated by these introductory sentences:

> The chimpanzee, as well as the gorilla, builds for itself resting places in which it passes the night. From their appearance one may call these places nests. The building of nests is for the observer one of the most striking activities of the animal. The kind of place, the location, the number of the nests, relations between newly erected nests and old ones no longer used, give us numerous conclusions concerning the habits of the animals. We thus make the building of nests the starting point for the descriptions.
>
> Noticeably contradictory are the reports with regard to these questions in the literature. (1920, p. 4.)

There follows description of observations which indicate that in the Cameroons Reichenow discovered no gorilla nests in trees; instead they were always either on the ground or in low bushes at a height of three to five feet from the ground. Nest construction is thus described:

> The gorilla builds his resting place in this manner: he bends over in a circular area of two to three meters diameter, all the standing plants toward the middle of the place, or in a sidewise direction, and arranges this tangle of leafy stems, knitting them together so that the round bowl-like nest has a diameter of one to one and a half meters. Torn parts of plants brought from other places I have never observed. If one tears apart such a nest one finds that all the plants are still rooted in the earth. In spite of a large number of thorny plants which are mixed in the undergrowth, the animals are skillful in finding places which are free from thorns. On the other hand, large-leaved plants and high standing grasses are preferred for the nests.
>
> These nests which are built somewhat higher above the earth in a low strong bush are completed in a corresponding way to those on the earth. The separate branches of the bush are partly bent outward, partly bent in toward the middle, and woven together. These higher nests are distinguished in that they form an extraordinarily soft and flexible foundation. One can compare them with a spring feather mattress. . . .
>
> The gorilla builds his nest in forests and in treeless regions. He lays value only upon the thickest possible undergrowth. I have found nests equally in the thick primeval forest and in the old deserted negro farms on which no strong stand of trees had yet grown up. That no particular shelter is used against the rain I can establish with certainty. . . . (Pp. 6-7.)

Concerning the location, grouping, and use of the nests we are informed that they are made at the approach of evening and deserted the following morning, being used for only a single night. Indicative of abandonment is the fact that the nests are frequently dirtied with feces. In regions where gorillas are abundant, deserted nests are common, and the author remarks that it is astonishing that they are so imperfectly known. The number of nests together differs greatly. Reichenow reports as high as thirteen. They are placed irregularly in groups eight to fifteen meters apart, two, three, or rarely four constituting a group. The stretches of thick undergrowth between groups constitute each a separate camp. In

the case of the thirteen nests found together there were five distinguishable groups. When a group consists of more than two nests the others usually are relatively small and presumably belong to partially grown animals. Reichenow believes that each group represents a family camp and that the nests in bushes or low trees and those which are constructed with special care and as he puts it "softly cushioned" probably are used by females with nursing infants.

Comparison of the reports of various observers leads Reichenow to suggest that there may be important local or racial differences in nest-building activities. The gorillas of the Cameroons, according to his findings, build either on the ground or near the ground in low bushes or small trees. By contrast, the gorillas of the Gaboon, according to the observations of von Koppenfels and von Oertzen, may place their nests in trees at such considerable distance from the ground as twenty feet, or they may rest directly on the ground.

From the varied supplementary and partially contradictory information we reach the tentative conclusion that there probably are marked variations in nest building which are correlated with species and variety, with local environmental conditions, or with season. Possibly the factors of each of these categories may be contradictory. Suggested is the existence of three principal types of nest-building habit, referable regionally to (1) the Cameroons, (2) the Gaboon, and (3) the mountains of East Equatorial Africa. Following Reichenow's terminology we may use the directional terms North, South, and East.

The facts relative to these local peculiarities may be summarized thus briefly. In the North or Cameroons region there is a predominance of ground nests, with occasional low tree nests of special construction. In the South or Gaboon region, according to the evidences presented by Savage and Wyman, von Koppenfels, and von Oertzen, and also by Aschemeier, there occur in addition to the ground structures nests which are located in trees at variable distances from the ground. We are not convinced by present evidences that there is any substantial difference between the placement of nests in these two regions. Von Oertzen, it is true, reports elevations of five meters, but this by comparison with the common nest placement of the chimpanzee is relatively low. Moreover, Aschemeier, reporting observations in the Gaboon, states that the nests of the gorilla are much more variable than those of the chimpanzee in location and construction and may easily be identified, if recently occupied, by their peculiar odor. He describes what one may infer to be tree nests, but more particularly nests constructed by bending and breaking the tops of saplings or by pulling and weaving together on the ground grasses, ferns, and bushes. One may legitimately infer from his description that the nests are commonly either on the ground or a slight distance above it. "One of the most interesting features about the beds of the gorilla is that they are made in close proximity to streams of water, where mosquitoes and insects of many kinds are particularly abundant." (Aschemeier, 1922, p. 177.)

As to the nesting habits of the mountain varieties of gorilla in Eastern Equatorial Africa, the evidence is fairly consistent in indicating the use of ground nests. On this point, citing the observations of Captain Arrhenius, Lönnberg (1917, p. 18) states that *G. beringei* makes a nest among the bamboo, on which it places twigs. Whether this is in the nature of nest lining, or as covering for the animal, we are not informed. In addition to the construction of ground nests by the mountain gorilla, Barns (1922, pp. 82-83) remarks that, although it is not generally known, these "gorillas are fond of bending over long bamboos to make a kind of low platform upon which to sun themselves and from which to pluck and chew the tender leaves." A mode of protection from accumulated rainfall also is indicated:

In the densely forested mountains of the equatorial forests rain-storms are of almost daily occurrence, so that unless sleeping quarters are se-

lected with some care the gorilla finds himself lying in a puddle from the water draining off his thick coat of fur. Thus it is we find this very human animal, if there is no hollow or overhanging tree handy, either scraping a hole for himself which he lines with ferns or twigs, and over which he sits, or forming a similar "nest" in the middle of a clump of bamboo, so that in either case he will not be sleeping in a puddle. (Barns, 1923, p. 130.)

Bradley (1922), Akeley (1923), and Gyldenstolpe (1923) offer entirely similar and consistent descriptions of crude nests placed in depressions of the ground beside or under tree trunks or in clumps of bamboo. Burbridge, however, as indicated below, affirms the occasional construction of tree nests.

The camps of the gorillas, occupied only for the space of a night, consisted of large bird-nest-like couches upon the ground, built with some care from the grasses and twigs of adjacent shrubbery. But no attention was paid to protection from the icy blasts of rain. Rarely they housed in the hollow openings of trees. On still rarer occasions, while the adult male slept on the ground, the mothers with their young built huge nests in the tallest trees. At such times the reason was evident, for a careful search disclosed the trail of prowling leopards, who, not daring to attack an adult gorilla, snatch one of their young when occasion allows. (1928, pp. 221-222.)

And Maxwell (1928, p. 446) says: "Whereas the adult male gorilla seems to prefer ground seats, it not infrequently happens that the younger members of a flock occupy small platforms, from four to six feet above ground level: such small platforms, which resemble nests after they have been occupied, are usually roughly built in the crotch of some large Hagenia tree."

We consider justifiable the conclusion that the mountain gorillas habitually construct their nests either on or very near to the ground, whereas the lowland varieties use, in addition to this type of nest, structures which are placed upon low-lying branches of trees, constructed by bending over the tops of trees or by weaving together low-growing bushes. It is by no means definitely established that conspicuously important differences in nest-building activities are characteristic of the several varieties of gorilla or of locality or season.

FOOD AND FEEDING HABITS

THE answer to the question, Is the gorilla herbivorous, carnivorous, or omnivorous? depends on the authority consulted. Because of this we must examine the observational evidences presented and attempt to evaluate them and reconcile their discrepancies.

The initial scientific description offered by Savage and Wyman mentions the *Amomums* as favorite food plants, and adds:

They eat only those species which have an acid pulp or arillus. Fruits distinguished by the opposite qualities of acidity and sweetness are eaten with equal zest. The stem of the *Saccharum officinarum,* the fruit of the *Elais Guineënsis* or oil palm, *Carica papaya, Musa sapientium,* and several others unknown to Botany are prominent on the list. (1847, p. 425.)

Seriously at variance with this simple straightforward description of vegetarianism is the report of Ford, who, having indicated that the gorilla feeds on various roots and forest fruits, informs us that according to the most reliable information it is also to some extent carnivorous. "When man is his prey, he devours him as he does animals that he can catch, though his sluggishness prevents his taking many animals as prey." (1852-53, p. 32.)

Du Chaillu thus affirms the report of Savage and Wyman:

The gorilla, though it has such immense canines, and though its vast strength doubtless fits it to capture and kill almost every animal which frequents the forests, is a strict vegetarian. I examined the stomachs of all which I was lucky enough to kill, and never found traces there of aught but berries, pineapple leaves, and other vegetable matter. It is a huge feeder, and no doubt soon eats up the scant supply of its natural food which is found in any limited space, and is then forced to wander on in constant battle with famine. Its vast paunch, which protrudes before it when it stands upright, proves it to be a great feeder; and, indeed, its great frame and enormous muscular development could not be supported on little food. (1861, p. 348.)

Wholly consonant with this description and in certain respects importantly supple-

menting it is the testimony of the natives (Bulus) as summarized by Jenks. We quote it because it has to do with feeding habits as well as with foods preferred.

> The foraging is also done independently as a rule, although it is frequently claimed and more or less generally believed by the Bulu that the "old man" sometimes has his food brought to him, as, for instance, when the gorillas are eating the fruit of a tall tree. They find most of their food very early in the morning or late in the day. They also commonly feed on moonlight nights. No record is found that they store food. Their food consists of many kinds of forest fruits, from shrubs and trees, and also of such bananas, plantains and sugar cane as they can secure from the more or less deserted "old" gardens. These gardens are their common haunts. They stay for days, weeks, or even months in one section, and then suddenly change locality. They usually return at the next season; and thus are seasonal migrants. (1911, p. 57.)

Possibly the evidences available to, and forcibly presented by, Savage and Wyman, Du Chaillu, and others might have settled opinion for an indefinite period had not Falkenstein, a reputedly excellent and reliable observer, emphatically asserted that the gorilla both in its natural state and in captivity takes animal foods, especially insects, birds, and birds' eggs, as well as vegetable products. Referring, it would appear, especially to captives, this author insists that flesh is not only readily taken by the gorilla but is necessary to keep it in good condition (1879, p. 151). One senses in Falkenstein a prejudice against vegetarianism and the deep-seated conviction that animal products are essentials of the primate diet.

It is almost as though Garner had taken his cue from Ford or Falkenstein, so like theirs is his account of the gorilla's food preferences.

> The food of the gorilla is not confined to plants and fruits. They are fond of meat, and eat it either raw or cooked. They secure a small supply by catching rodents of various kinds, lizards and toads; they are also known to rob the nests of birds of the eggs, and of the young. A native once pointed out to me the quills and bones of a porcupine which he said had been left by a gorilla who had eaten the carcass, and he said that it was not at all rare for them to do so. The fruits and plants they live upon chiefly are acidulous in taste, and some of them are bitter. They often eat the fruit of the plantain, but prefer the stalk, which they twist and break open and eat the succulent heart of the plant. They do the same with the *batuna,* which grows all through the forest. The fruit of this plant is a red pod filled with seeds imbedded in a soft pulp, it is slightly acidulate and astringent. The wild mangrove which forms a staple article of food for the chimpanzee is rarely, if ever, touched by the gorilla, and the same is true of many other plants and fruits. (1896, pp. 229-230.)

Suspicion is aroused by these descriptions of mixed diet that the authors are confusing the feeding habits of captives with those of the free wild gorilla. Clearly this is inexcusable, for the food preferences and requirements may be quite different in the two instances. At any rate, with the ending of the nineteenth century knowledge of the foods and feeding habits of the wild gorilla was meager and wholly uncertain. Happily, as the evidence now to be presented will prove, the situation has been radically altered by recent observations.

First, we believe, among those to suggest that captivity may essentially change the nutritional preferences and needs of the gorilla is von Oertzen. From intimate acquaintance with the wild gorilla and with several specimens held captive in Africa, he affirms that in freedom they eat various tropical plants and their fruits. But, "after a long captivity, however, meat is taken with eagerness, and my animals got along better on animal diet than on a vegetable one, even when I obtained for them the food which they had preferred in freedom." (1913, p. 13.)

Von Oertzen's suggestion, which is important because it serves to reconcile the most serious contradictions exhibited, is accepted and further supported by Reichenow (1920, pp. 20 ff.) who, with characteristic definiteness of observational knowledge and also with insight, discusses the nutritional habits of the gorilla. A brief but nevertheless excellent historical *résumé* in a section entitled "Food and wandering life" is followed by critical examination of dietary preference. Reichenow concludes that although it is primarily herbivorous, in free-

dom it may sometimes eat birds' eggs. Meat eating he believes however to be an acquisition of captives which is correlated with change in the intestinal fauna and flora.

> I was able to establish that in the intestine of free gorillas and chimpanzees infusoria were regularly present in large numbers, which were closely related to those species of infusoria that play a large rôle physiologically in the intestinal digestion of ruminants. These infusoria aid their hosts to make use of plant foods by reason of their ability to digest cellulose, and in that they are themselves destroyed in large numbers and digested in the intestine they offer certain evidence of the consumption of flesh. In apes in captivity these infusoria after several weeks disappear from the intestine. To me it does not appear rash to connect the awakened need of the animals for meat with this disappearance. (1920, p. 24.)

Although in all respects the general account of gorilla foods and feeding habits offered by Reichenow is the best available, a useful general account is offered by Heck (1922). Whereas the Reichenow discussion is topical, continuous, and logically constructive, that in Brehm's *Tierleben* is arranged under authors and is therefore scattered through the chapter and disconnected.

The observations and discussions reported above have referred solely we believe to the lowland gorillas of West Africa. It therefore remains to consider what is known about the feeding habits of the varieties of mountain gorilla. In this instance authorities agree in characterizing the animal as a vegetarian. Lönnberg (1917), Bradley (1922), Barns (1922, 1923), Akeley (1923), Gyldenstolpe (1923), Maxwell (1928), and Burbridge (1928) are our chief informants. Typical of the descriptive statements offered by these authors are the following taken from Bradley and Barns.

> We never heard of any of the native shambas being raided by the gorillas, for here the gorilla food—the wild carrot and parsley and fresh succulent green growth of the high lands—was extraordinarily plentiful, and, below the upper forest, were the bamboos whose fresh green tips were always in season. The gorilla is a strict vegetarian like the elephant and buffalo—three of the four most dangerous animals of Africa. It behooves one to walk softly with vegetarians! (Bradley, 1922, p. 131.)

> As regards his food the gorilla is very conservative, and never so happy as when in his favourite haunt of a forest of bamboos munching the succulent ground shoots or climbing over the bamboo stems, upon which he is in the habit of making a platform to take a sun bath. Speaking from a special knowledge of the eastern Congo gorilla, it may be said that its food consists, apart from bamboo shoots, entirely of herbage—docks, sorrels, hemlocks, etc.—although honey may be part of the menu. He does not grub for roots, neither does he eat fruit as a general rule (although the West African species seems to be rather more omnivorous). These facts concerning his diet are borne out by my examination of the stomachs of the several animals I have shot and accumulated "droppings." The latter resemble those of a horse. (Barns, 1923, p. 129.)

From our own experience with a half-grown captive mountain gorilla (Yerkes, 1927, pp. 31, 144) we conclude that the immature *G. beringei* may be kept in health and caused to grow rapidly if fed on a diet of vegetables, fruits, and milk. Possibly the milk is an essential, but certainly meat is not requisite.

The evidences available definitely suggest, and in our judgment justify, the following tentative statement. The gorilla is primarily a ground-feeding herbivore, which eats enormous quantities of plants and their fruits. It is extremely careless and wasteful of foodstuffs and therefore is compelled to wander over a considerable area. Partial to berries and other fruits which grow on bushes and trees, it climbs as necessary to obtain them. But certainly in case of the mountain varieties, and probably also the lowland forms, the bulk of the food consists of the tender portions of low-growing plants. It is indicated that the mountain gorilla is more markedly herbivorous than the lowland varieties, which by contrast are more frugivorous. The indications are clear that as between the food preferences and requirements of free-living and captive gorillas there are radical differences. The former are ordinarily either strictly vegetarian or only occasionally take such animal foods as insects, other small animals, and eggs, whereas the latter may come to prefer raw or cooked meats to fruits or vegetables. In all probability Reichenow is correct in sug-

gesting that these dietary differences are correlated with the intestinal fauna and flora. In a later section on the care of gorillas in captivity, we shall further consider the topic of foods and habits of feeding.

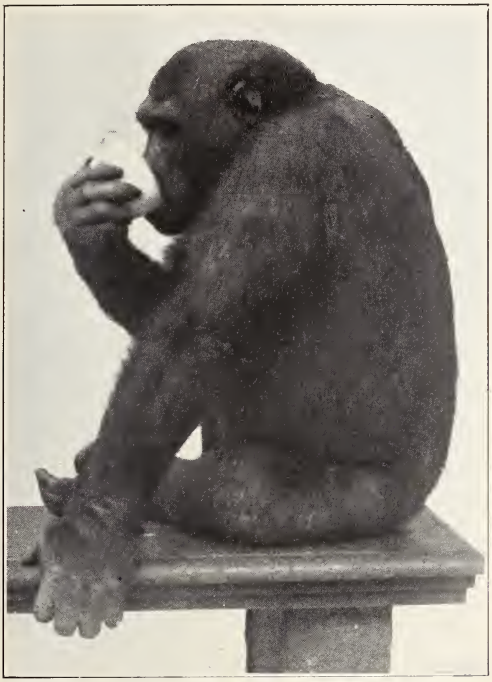


Fig. 132. Sultan, aged about five years, drinking from a cup. Courtesy Alyse Cunningham and Thomas Fall, photographer.

Of the drinking habits of the wild gorilla we have discovered no adequate description in the literature. Presumably there is nothing strange or from the human point of view peculiar about them or the facts would have been recorded. On scant and indefinite observational evidence we hazard the guess that the wild animal ordinarily drinks by bending over, applying the slightly protruded lips to the surface of the water, and sucking it into the mouth. There is no suggestion that it dips or scoops up water with its hand or sucks water from hand or arm as do the gibbons.

Concerning the drinking habits of captives we glean certain fragments of information from the following authors. The young male observed by Falkenstein (1879, p. 153) drank either by carrying the liquid-containing vessel to its lips or, if more convenient, by leaving the container on the floor and applying the lips to the liquid and sucking it up. Garner (1896, p. 230) informs us that captive gorillas drink like men, by placing their lips against the rim of the container instead of thrusting them into the liquid. They take readily water or milk, but are more likely than is the chimpanzee to refuse persistently alcoholic beverages or other unfamiliar liquids.

That he drank water eagerly and in large quantities, supporting himself upon his hands, lowering his head, and sucking up the liquid with pointed lips, is Hermes' (1892, p. 579) pertinent description of the behavior of a captive. Similar is the description by Grabowsky (1904, p. 258) of the drinking behavior of the famous Breslau captive "Pussi."

Of the few facts thus indicated concerning the drinks and drinking habits of the gorilla the most important perhaps is its relative unwillingness to drink or even to try unfamiliar liquids. In this respect the chimpanzee is very much more adventurous and also more readily adaptable.

CHAPTER THIRTY-FOUR

HYGIENE, HEALTH, AND CARE IN CAPTIVITY OF GORILLA

CLEANLINESS AND OTHER NATURAL TENDENCIES

THE title "instincts" might be given these paragraphs if we were willing to make a certain assumption and also to run the risk of misleading some readers. We prefer to avoid initial prejudice. Our index reveals under the term instinct few references. That the instincts, granted there are such, of the chimpanzee should not have been listed may seem strange in view of our considerable acquaintance with the animal, but we are so ignorant of the ways of the gorilla that a list could scarcely be expected. Presumably there are as few or as many partially or wholly innate tendencies in the gorilla as in any other anthropoid ape, or indeed in man. Yet few activities are so described in the literature that we can with assurance consider them innate.

Nest-building behavior, by some observers considered instinctive, may be partially so, as far as available evidence goes, or it may be imitational, traditional, or a result of definite parental or adult tuition. No observer has eliminated the possibility of social influence. The tendency to chest beating, even from early childhood onward, the tendency also to pound objects or to use them for noise production, are as definitely suggestive of innateness as is nest building.

Instinctive timidity or fear may exist, but proof is lacking. Individuals have been crudely tested with such objects as snakes, leopard skins, and more definitely by Yerkes (1928, p. 59) by bringing the gorilla near to large carnivores, such as the lion, tiger, leopard, and bear. Fear was exhibited under such circumstances, but it was neither extreme nor free from suggestions of the influence of experience.

We may not claim that cleanliness is more largely innate than acquired, but at any rate the records abundantly prove that free wild gorillas and captives, when healthful and in reasonably favorable environment, are scrupulously cleanly. This extends from neatness of person to cleanliness of nest or bed and immediate environment. The literature contains little on the subject, but aside from reports of the behavior of certain obviously pathological specimens, comparable perhaps with cases of insanity in man, they consistently support the general statement made above.

Bradley (1922, p. 132) records not only the personal cleanliness of mountain gorillas, but also their apparent healthfulness and freedom from parasites. And Falkenstein (1879, p. 153), of his much-observed captive, writes:

> Noteworthy moreover was his cleanliness; if by chance he became caught in a spider's web or waste stuff, he sought with comic aversion to free himself from it or held up both his hands to let himself be helped. He was completely without any odor himself and loved above all things to play in the water and splash around, yet when he had just taken a bath that fact did not hinder him from amusing himself immediately and rolling around in the sand with the other apes.

Likewise Cunningham (1921, p. 119), from her intimate acquaintance with immature lowland gorillas, and Yerkes (1927, pp. 31-32), from similar acquaintance with a mountain gorilla, indicate not only personal cleanliness and neatness, but the ready acquisition of habits of cleanliness with reference to bed and cage.

DISABILITIES AND DISEASES

"THE Gorilla is very delicate, and rarely lives long in captivity, even in his own land." Forbes (1894, II, 187) thus expresses what then was generally believed in scientific as well as lay circles. Delicacy

is a matter of interpretative inference. Whether it is justified by the observational data which have accumulated it is a part of our task to attempt to discover. No systematic investigation of the disease susceptibility, resistance, or vitality of the gorilla has come to our attention. Such significant information as may be gleaned from the many authorities who touch on the subject casually we shall now present.

By Walker (1861, p. 373) it is related that a young female, held captive in Africa, "finally died from dysentery and chagrin,—the latter caused by her keeper being prevented by his other occupations from paying her so much attention as she had been in the habit of receiving." We give the entire diagnosis despite our suspicion that dysentery may have been an adequate cause of death.

The captive so successfully handled by Falkenstein experienced a series of illnesses which has been described most illuminatingly by Broesike (1877). The ills include various disturbances of the digestive and respiratory systems, and death finally resulted from pneumonia. Falkenstein contributes the following peculiarly interesting if not also surprising observations:

> Thunder alarmed him, and rain pattering on the roof of leaves, or even more, the long drawn tone of a trumpet or fife, so much so that sympathetically digestion was hastened, and the animal kept at the greatest possible distance from the source of sounds. In various light indispositions we made use of such music with results not better attained in other cases through the use of purgatives. . . . Our protégé throve amazingly to the beginning of February, 1876, when a serious illness with convulsions came upon him, which could only be regarded as a peculiarly dangerous malarial infection. (1879, pp. 154-155.)

From this illness apparently the animal recovered, to succumb later to what Falkenstein describes as galloping consumption with serious catarrh of the intestines. Presumably the pneumonia referred to by Broesike added itself to the other diseases.

In the Breslau captive, so well described by Grabowsky (1904), there is obvious abnormality, for if both age and weight are given correctly the animal must either have been stunted by nutritional insufficiency or dwarfed by lack of endocrine balance. Nevertheless it appears from the records that the specimen got along tolerably well during several years. Finally nephritis developed. The animal suffered severe cramps and ultimately died from the disease.

Sokolowsky presents a most discouraging picture of the condition and fate of gorillas which were at various times kept in the Hagenbeck Park in Germany. Usually the animals survived for only a few days. The author attributes this to change of climate and food.

> The appetite of the gorillas became less and they paid less attention from day to day to their surroundings. They sat still in one place without bothering themselves about anyone, and at most plucked at the straws about them. Their appearance became increasingly sad. I could observe that in order not to be seen they tried to avoid the eyes of observers by holding their hands before their faces. . . . Then began coughing and sniffling. The bodies of the animals also seemed to shrink. After that they did not live long. . . . Intestinal catarrh and inflammation of the lungs were evident. (1908, p. 20.)

A disease of the skin, presumably scurvy, accompanied by inflammation of the gums, is reported by von Oertzen (1913, p. 13) in a captive which he had opportunity to study. The animal was practically hairless. The condition of the skin is described as persisting despite varied and changing diet. Von Oertzen deems it contagious. The inflammation of the gums he reports as subsiding as soon as the teeth were extracted.

Keith has most nearly approached systematic examination of the diseases of the anthropoids, but unfortunately his lectures on the subject (1914) are published only in abstract. One learns from them that the gorilla is especially susceptible to tuberculosis. Undoubtedly he discovered a sad dearth of information on the medical history and pathology of the gorilla as contrasted with the other manlike apes.

The only gorilla which for more than a few days survived captivity in the New York Zoölogical Park, the specimen "Di-

nah," which was brought to America by Garner, we are told by Hornaday (1915, p. 1185) after a time became partially para-

Fig. 133. Portrait of female *G. gorilla*, aged approximately three years. Courtesy New York Zoölogical Society, E. R. Sanborn, photographer.

lyzed. Infantile paralysis was suspected, but examination did not confirm the diagnosis.

Important observations of the parasites occurring in the blood and intestines have been made by Reichenow (1917, 1920). He has discovered among others the organisms responsible for tropical fever and malaria, and his publications indicate that he believes gorilla and man sufficiently closely related to suffer from the same or closely related diseases and to be susceptible to the same types of pathogenic organism.

The occurrence of what is usually referred to as the common cold in the gorilla has been noted by various observers, and by Akeley (1923, p. 246) and Burbridge, in conversation with us, the belief has been stated that it may be contracted by contact with man. Heck's general account of the gorilla contains mention of the prevalence of respiratory and digestive disorders and the frequency also of intestinal worms and forms of anemia. Barns (1923, p. 132) refers particularly to the apparent healthfulness of the mountain gorilla (*G. beringei*) and its freedom from macroscopic external and internal parasites.

Among the diseases discovered in captive gorillas and most frequently reported as primary or contributory causes of death are such disturbances of the digestive system as dysentery, appendicitis, and colitis. In the respiratory system appear common colds, pneumonia, and tuberculosis of the lungs. Of diseases of the blood, malaria and anemia are mentioned; of diseases of the skin, frequently referred to, but without sufficient definiteness and detail to permit diagnosis, the falling out of the hair and scurvy are recorded; likewise, as disease of the kidney, nephritis. These are but random samples, as it were, of the pathological conditions which may appear in this type of ape. That knowledge is extremely meager and of uncertain value is obvious.

The evidences do not convince us that the

Fig. 134. Profile of young female *G. gorilla*. Courtesy New York Zoölogical Society, E. R. Sanborn, photographer.

gorilla is delicate or less resistant than are the other primates to invasion by pathogenic organisms. Our tentative explanation of the

fact that they promptly succumb to the usual conditions of captivity runs along these lines.

It is assuredly true that the animals do not adjust readily to new environmental conditions, new foods or companionships. They therefore tend to become weakened by inadequate or improper nutrition, and in consequence fall prey to pathogenic organisms within or without the body. That they are less resistant to the diseases of human civilization than is man himself would naturally be assumed, since they presumably lack the acquired immunities of man; but that they are more susceptible to such diseases than are the other manlike apes we discover no reason to believe. Indeed, as we review the history of certain well-known captives we feel increasingly assured that timidity, distrust, slowness of adaptation to novel environmental conditions, and lack of natural companionship are primarily responsible for the peculiar difficulties which man meets in attempting to tame and domesticate the gorilla. Without fear of contradiction we assert, on the basis of the evidences in the literature and those obtained from our own observations, that sympathetic intelligent care ordinarily avails to keep a captive in excellent health and spirits, barring such accidents as even man himself may not escape.

The following facts are worthy of careful consideration and suggestive of problems for the psychobiologist. We draw first upon the experience of von Oertzen.

With many highly developed animals captivity presents many difficulties, for besides the bodily care the sensitive soul above all needs understanding treatment. This chief factor is still too much undervalued. What influence mental depression may have upon bodily condition everyone may judge who has seen how many negroes who have never yet come into contact with Europeans, succumb in captivity, although they receive better food than in their native freedom. The gorilla, although it stands so high, is still essentially different from man, so that it might be possible to influence old animals betrayed into captivity to renounce their freedom. But all attempts at acclimatization undertaken heretofore with gorillas have failed; some animals die early, others late; with one exception none has endured captivity in Europe longer than one year. I believe one may only be successful when one obtains the animals at an age when they have not yet come to consciousness of their existence and their surroundings, where the organism has not yet endured the one-sided, wholly peculiar conditions of the battle for existence, where protection is still practiced by the mother. The natural mother must be replaced by a black nurse who will treat her nursling exactly like a child. I can find no injury to humanity in a woman nourishing an orphaned animal child in order to perform a prominent service to science. Indian women suckle from motherly feeling young cats, dogs, even pigs. Why should not a negress bring up a young gorilla? Naturally milk is in the beginning an important condition. Condensed milk as it is used in the tropics must lead to a weakening of the organism and to illnesses. The growing gorilla must become accustomed to the manner of life of men. One must learn to understand the sounds of the animal and to seek to bring him into an understanding of human words in order to exercise an influence upon his feelings. The resistance to bodily ills is very slight in the gorilla; especially bodily and spiritual demands, such as the sea journey makes on an animal, must be prepared for by getting it accustomed beforehand. Great trouble and much understanding are needed; but I believe that success would then follow. Gorillas caught heretofore have mostly been taken care of in Africa without any understanding, and thereby the seeds of death have been sown in them. (1913, pp. 10-11.)

Not less significant than the experience of von Oertzen are the histories of those few captives which appear to have fallen into the hands of persons with ready sympathy, intelligence, insight and skill, if not also experience. There is first the Dublin gorilla "Empress," who for over three years lived comfortably in the city zoölogical garden. "Pussi," of Breslau, even though dwarfed or stunted, survived for some seven years in the inhospitable climate of that city.

"John Daniel" and "Sultan," in London, were successfully cared for and kept for a number of years in health and contentment by Miss Alyse Cunningham. Likewise "Congo," the mountain gorilla captured by Ben Burbridge, for a period of some eighteen months, after which she was transferred to other hands, was successfully kept by Mr. and Mrs. James Burbridge in Jacksonville, Florida. The earliest gorilla on the

British Isles, the Wombwell specimen, it should be remarked, also was taken care of by a woman.

From the history of the treatment of captives it is possible to read the lesson that ignorance, stupidity, and carelessness, often accompanied by the best of intentions and endeavor, are responsible for the disabling, decrepitude, or early death of most captive gorillas.

That the animal is more difficult to understand, to make friends with, to train to new habits of life, and to accustom to new types of social relationship than either the chimpanzee or the orang-outan, is abundantly clear from trustworthy reports. But we are not prepared to grant that this implies relatively low disease resistance, delicacy, or lack of vitality. Possibly it is because the gorilla is mentally more complex and more like man psychobiologically, and therefore more insistently in need of the treatment which is required by human beings, that it so sorely suffers from being treated as an infrahuman animal. But after all the evidences are marshaled as arguments for or against the position which we are tentatively holding, the fact remains that with the possible exception of "Pussi," not a single gorilla is recorded in the literature as having been reared in captivity from infancy or childhood to maturity. In a few instances orang-outans and chimpanzees have been so reared and for many years have lived in health and seeming contentment. To what in them or in us may we attribute the difference? We have suggested the direction in which we should expect to discover answers to the question and have thus indicated assemblages of problems of extreme interest to the psychobiologist and the medical investigator. Our conviction is deep seated, and until knowledge of the characteristics and environmental relationships of the gorilla becomes more abundant, more definite, and more accurate, we shall continue to believe that specimens of the human animal, if captured by the gorilla and treated no more sympathetically, intelligently, or suitably than most captive gorillas have been treated by us, would appear as delicate and prove as short lived as have captured gorillas.

DOMESTICATION AND CARE IN CAPTIVITY

By citation of authority it may be proved that the gorilla is untamable or instead that it on occasion readily and naturally becomes reconciled to human companionship. Because of conflicting observations and diverse opinions on this matter, it is essential to examine reports critically and interpretatively. Fair sampling will as well serve our purpose as complete and exhaustive review. We therefore shall follow that method.

Du Chaillu, from experience with several captives, concludes that the gorilla is practically untamable. Throughout his writings he emphasizes the greater ferocity and resistance to human influence of the gorilla as compared with the chimpanzee and orang-outan. One might maintain that this author's observations were not sufficiently extensive to reveal the whole truth, or he might suspect Du Chaillu of inability to understand and command the confidence of his animal subjects. However that may be, his opinion is flatly contradicted by that of several accredited authorities. We shall mention a few of them.

Falkenstein (1879, p. 151) reports the rapid adaptation to life in captivity of a specimen which was in wretched condition when it came into his hands. His report, in its essentials, is confirmed by the experience of Cunningham with three captive lowland gorillas, of Captain Heinicke as recorded by Heck (1922, p. 696), of Carpenter, Burbridge, and others.

We must therefore conclude that tamability, instead of being impossible, is relatively more difficult in this anthropoid ape than in others and that it depends to a very considerable extent on individual temperament, stage of development, sex, and the circumstances of capture and care. For indeed it is clearly apparent to the careful and critical reader of the literature that the animal is highly individualized psychobio-

logically, and probably in this respect no less variable than is man; that the nature of the organism changes radically between birth and senility; that the sexes are extremely different temperamentally, if not in other respects which importantly affect taming or domestication, and finally, that the circumstances of capture and care, largely accidental, are extremely diverse, sometimes fortunate and as often unfortunate.

Domestication of the gorilla, in the ordinary sense of that term, is impossible. It may be rendered gentle and amenable to human control, but never has a specimen been known so far to subject itself to human desires as to render monotonous service. We have failed to find even record of specimens trained for exhibition purposes. Evidently this means that they do not prove satisfactory subjects. On the one hand, they may be, and we believe are, resistant to ordinary methods of tuition or instruction; and on the other, they may be, and we believe are, unsuited by temperament to stage or exhibition uses. Essential undeniably in the successful handling of captives are avoidance of injury or shock, the speedy establishment of mutual confidence or sympathetic rapport, training to the acceptance of unusual foods and new habits of feeding, suitable companionship and amusement or entertainment, and adequate measure of freedom with appropriate shelter and a hygienic and otherwise healthful environment. Before discussing the importance of these requirements we would examine the pertinent literature for such light as it may throw on success or failure in maintaining captives in health and contentment. We cite below typical instances of success and of failure. All are relative, for no one has yet achieved the supreme success of keeping a gorilla over a period of years.

The Wombwell gorilla, according to the statement of Waterton (1858), was handled with wisdom and patience. Of its diet we know only that it was fond of celery. The case may not be labeled a success because the animal survived for only a few months. More impressive by far is Falkenstein's description of the reaction of his captive to intelligent and humane treatment:

> It was my first care to acquire all the forest fruits obtainable, and also a mother goat, in order to restore the lost strength of the young anthropoid; naturally we followed his attempts to eat with great interest and felt in high degree rejoiced when he not only took the milk with pleasure but also chose with awakening appetite different fruits, especially the gnarly *Anona senagalensis* which grows on the savannas. In spite of this he remained for a long time so weak that he fell asleep while eating and spent the greater part of the day curled up in a corner sleeping. Gradually he became accustomed to cultivated fruits like bananas, guavas, oranges, mangoes, and began, the stronger he grew and the oftener he was present at our meal times, to seek for himself everything that he enjoyed. Since he was gradually brought to take any kind of food and to digest it, the outlook for transporting him successfully to Europe grew better and better. (1879, pp. 150-151.)

Classifiable among the failures is a case described by Lenz (1875, pp. 256-257) in a letter to Hartmann. We abstract and paraphrase the account. The specimen was a male about two years old which readily became accustomed to captivity. It was kept fastened by a long chain and given thus plenty of room to play. During the day it mostly sat in a barrel of straw and at night, lying on the straw as a bed, it was covered with a sail cloth because sensitive to the cold wind and rain. Usually it sat crouching, with arms crossed over its chest and with back against some object to protect itself from possible enemies. It slept lying on side or back, with its hand for a pillow. Then follows a telltale admission—the gorilla's hands were full of vesicles which contained insect eggs. Rice, bread, milk, ship biscuit, and other articles were offered as food, but the captive ate little. He preferred bananas, oranges, and sugar cane, but liked still better the kernel of a certain red fruit. Embarked for the Zoölogical Garden in Hamburg, he died two days out.

A part of the story of another captive, unfortunate in its human association, is told by Hermes (1892, p. 578):

> He always made the impression [writes Hermes]

of a morose, wild, unsociable companion whom no one could trust.

Moreover he was, at least at the beginning, very timid and shy. . . .

Of a stick or whip he was greatly afraid. In his previous captivity, he must have had a close acquaintance with them; otherwise I cannot explain his behavior. For instance, during the first days, if I approached the bars of his cage, he would remain quietly sitting close to the netting, but without removing his eyes from me. Once, when I accidentally entered the room in front of his cage with a stick, he fled, looking angrily at me, into the furthest corner. From that day he hated me, and fled whenever I approached the cage, although I had neither stick nor whip in my hand.

There is nothing to indicate that Hermes ever succeeded in winning the confidence and affection of the animal, nor indeed that his keeper or caretaker succeeded better, for we read:

His keeper could clean his cage without danger. . . . If the broom came too near the gorilla he struck at it and growled. If the keeper, while in the cage, handed him a fruit, he struck it out of his hand, always growling, or he took it, when offered repeatedly, and threw it on the ground. (P. 579.)

Failure to establish new feeding habits is also confessed, for we read:

On his trip from the west coast of Africa to Liverpool, and probably also in his home [!], he had lived almost entirely on bananas and he was so accustomed to them that when I could not obtain any he went hungry for two days rather than take any other fruit. Among those offered him he finally chose dates, to which he then gave the preference even when bananas could again be obtained for him.

At first he took two pounds of dates daily, later he was satisfied with half that, and finally his appetite decreased more and more. It often happened that he ate nothing at all for one or two days. (P. 579.)

One scarcely can be enthusiastic about the treatment accorded this captive. Plainly the failure convicts the caretakers of incompetence, even though it also suggests limited adaptiveness in the gorilla.

For the sake of contrast we alternate failures and successes. Now a success is in order. We choose that of Garner, who, on commission from the New York Zoölogical Park, in Africa accustomed a young gorilla to captivity, and having taught it to eat various readily procurable foods, journeyed with it to New York. "Dinah is as fat and buxom as a pet pig, and eats like a gourmand." Then referring to Dinah and a male companion named Don, the author continues:

In so far as their dietary is concerned, both of these apes are now fairly well civilized, which is a great consummation. They both eat bread, various kinds of cooked meats either fresh or cured, sweet bananas, mangoes, pineapples and other cultivated fruits in certain stages of ripeness. Nevertheless, they are rather capricious and sometimes fastidious about their food. At one time they will eat the crust of bread and refuse the crumbs, and at other times they exactly reverse this order. Occasionally they will eat both, and in these whims they do not always act concurrently. Sometimes they eat the succulent part of bananas, at other times only the skin, and at still others they eat only the thin inner lining of the skin. On many occasions they bite off the points and eat them, while at other times they peel the fruit, break it in two about the middle, take a bite from each of the freshly-broken ends and throw the rest away. They are both especially fond of uncooked ham and also of roast or ragout of chicken; but they do not relish fried meats, if they can get other kinds; although sometimes they eat fried bacon. (Garner, 1914, pp. 1103-1104.)

The discouraging sequel to this propitious introduction is that Dinah lived for only a few weeks in New York. Garner has ideas as well as convictions about the proper treatment of anthropoid apes in captivity, and although he refers to both the gorilla and the chimpanzee it appears entirely appropriate to summarize at this point his advisory recommendations. In one of his books (1896, pp. 263 ff.) he devotes an entire chapter, and a valuable one it is, to discussion of the subject. Much impressed by the peculiarities of the climate of the gorilla's habitat, he insists that high humidity and decaying vegetation are essentials for the gorilla; that a variable temperature is desirable, that a pool of water should be always accessible, and that both water and sheltering house should be kept at from 60 to 90° F. Fresh air, sunlight, and shade should also be properly provided.

The ape does not need to be pampered: on the contrary, he should be permitted to rough it. Half of the gorillas that have ever been in captivity

have died from over-nursing. By nature they are strong and robust if the proper conditions are supplied, but when these are changed he becomes a frail and tender creature. They should not be restricted to a vegetable diet nor limited to a few articles of food of any kind, but should be allowed to select such things as they prefer to eat. (1896, p. 268.)

Facilities for amusement, companionship, and entertainment are to be supplied, and withal, the captives must be treated with firmness and consistency. "When they become sullen or obstinate they should not be coaxed or indulged, nor yet used with harshness. They should either be left alone for the time or diverted by a change of treatment." (Garner, 1896, p. 270. See also Burton, 1876, I, 245.)

We earnestly recommend to anyone who contemplates the acquisition and care of a gorilla the careful and critical reading and rereading of Garner's suggestions, for into the chapter which we have thus inadequately summarized he has crowded the pertinent experiences of many months of jungle life and intimate association with the African anthropoids.

Although we have already several times referred to the remarkable Breslau specimen "Pussi," we must cite her as an example of the successfully kept gorilla.

The question of nourishment [says Grabowsky (1904, p. 256)] was a very difficult one at the beginning. When the animal arrived she ate, in addition to ripe bananas, only hay, which she appeared to relish. . . . A few weeks after her arrival our female scorned bananas and other fruits as food and ate instead only bread and wheat crusts; moreover she ate by preference clover hay soaked in boiling water, of which daily she consumed a very large quantity, with eagerness pulling off the seeds and leaves from the stem and chewing them; she liked also fresh clover with the blossoms and the young foliage of acacias and rose blossoms. . . . At one time she easily became accustomed to the addition of somatose to her food. Toward the experiment of giving her dried vegetables of different kinds instead of hay she was consistently negative. Eventually she learned to appreciate dates, figs, dried fruits, St. John's bread, peanuts, carrots, and our native fruits, stone and kernel fruits and berries, especially blueberries.

It will be recalled that this animal was brought to Europe in 1897 and lived in the Breslau Zoölogical Garden until 1904. Despite diminutive stature and slow growth, she apparently continued in fairly good health and spirits during much of the time.

Again a contrast. It is that afforded by the typical zoölogical garden experience. The captive gorilla lives only a short time. Evidences may be taken indiscriminately from the Hagenbeck Park in Stellingen, Germany, the London Zoölogical Garden, the New York Zoölogical Park, and indeed almost any of the gardens or parks of Europe or America which have attempted to keep gorillas as exhibition specimens. As sources of information in this matter we would cite especially Sokolowsky (1908), Hagenbeck (1909), Mitchell (1911), Hornaday (1915), and Knauer (1915).

To conclude with an array of successes we would again call attention to the Dublin gorilla, whose characteristics and treatment are so well described by Carpenter (1917, pp. 125 ff.). Satisfactorily acclimated, with good appetite, she throve on bread, milk, fruits, peanuts, green stuff, including lettuce and dandelions. The fact that this animal, "Empress," died of a digestive disorder, probably appendicitis, suggests the possible inadequacy of her diet. Possibly, however, the cause of death was due to quite other conditions. Miss Cunningham, as related in her publication (1921), accustomed her gorillas (although only one is referred to in the article in question, she has at the time of writing had successful experience with two others) to take a variety of foods as would a child. Indeed, the animals frequently if not regularly were brought to the table, and in addition to being given certain staple articles they were allowed to choose from among the meats, vegetables, and fruits provided for the family such as appealed to them. Quite different was the treatment of the Burbridge gorilla Congo, for throughout two and one-half years of captive existence she took very few foods. Fruits she was extremely partial to, although she rapidly tired of most of them if they were offered regularly. The only vegetable which she accepted consistently over a long period was

sweet potato or yam. During the greater part of her stay in Florida she lived principally on baked sweet potato, baked banana, and milk. Acorns, other fruits, and occasionally green vegetables or herbs she sometimes accepted or again rejected.

A young *G. gorilla,* with a chimpanzee companion, now in the Philadelphia Zoölogical Garden, has been kept there in health and vigor for more than a year.

Having devoted a disproportionate amount of space to exhibiting the principal facts which appear from human experience in maintaining gorillas in captivity, we would briefly summarize this section by indicating from our digest and interpretation of the literature, and from our own experience in helping to take care of the captive gorilla Congo, what appear to us the primary and minimal essentials to success in dealing with this rare and undoubtedly highly organized primate. We shall arrange our points by paragraphs.

The subject should be captured at an age preferably of not less than one year nor more than two, without physical injury and with the minimum of fright or mental shock. From the moment of capture it should be treated kindly, considerately, sympathetically. Every precaution should be taken to avoid the development of unfavorable reaction toward man and to encourage friendly attitude and response.

Promptly the captive should be transferred from point of capture to temporary or permanent quarters in which, with the maximum of freedom consistent with security and protection of the individual and of its caretakers, it may be handled readily by those who have charge of it, suitably fed, and provided with opportunity for varied activity and especially forms of amusement. There is grave danger that in process of transfer the captive may acquire diseases suffered by its captors, such for example as common cold, influenza, tuberculosis.

As early as possible systematic attention should be given to nutritional regimen and the animal taught to taste and to eat, not only the varieties of food to which it has been accustomed in nature, but many other nutritionally similar articles which are for one reason or another more easily provided. Varied tuitional means may be used to further this training. In many instances imitation proves helpful, for when the captive sees its caretaker eating a certain kind of food with evident relish, it is more than likely after a time to try it, to become accustomed to the unusual flavor or texture, and to eat it with increasing readiness or even eagerness. Nutritional hygiene should be rigid and unremitting. No food should be given to the young gorilla which would not be safe and otherwise suitable, hygienically considered, for a human being of like age. Because of the often mentioned dietary capriciousness and fastidiousness of the gorilla it should as speedily as possible be accustomed to a very considerable variety of foods, and the supply offered from day to day should be varied in order to avoid monotony and loss of interest or appetite.

Inseparable from proper nutritional hygiene are companionship and opportunity for entertaining activities, for it must be inferred from the body of the literature that the lonesome, despondent, and physically depressed captive, if with difficulty prevailed upon to take food, will not properly assimilate it. Hence indications are that suitable interest in and inducement for activity must be provided either by companionship or otherwise. That species companionship is not absolutely essential is definitely proved by the case of the Florida gorilla Congo, who for many months grew rapidly and appeared entirely contented, although lacking contacts with other creatures than man and occasionally a dog. Probably the discreet and wise precaution is the provision of at least two individuals, the additional one being preferably either gorilla, chimpanzee, or orang-outan. Lacking species companion, some other mammal apparently may suffice. The cage enclosure or immediate environment should provide facilities for simple acrobatic and like forms of entertaining activity. Whereas in the preceding paragraph we sought to indicate

minimal requirements for nutritional hygiene, in this we attempt to designate some of the most important in mental hygiene.

Proper housing or environing in the narrow sense, we have reserved until last, chiefly because the four groups of requirements already stated must be complied with in order to justify the trouble to house an animal. Undoubtedly freedom in a safe environment is preferable to caging or other form of restriction, but we must assume that ordinarily the captive must be placed in some sort of enclosure and provided with a shelter from sun, frost, or rain, suitable to the region. If room or rooms constitute the housing arrangement they should in any except the tropical zone be provided with heat so that, as Garner has suggested, the range of temperature may be from approximately 60° F. upward. The room which serves thus as shelter from wet and cold should communicate with fresh-air quarters or cage to which the animal may at all times have access and in which it may get an abundance of fresh air, sunshine, fresh water, and varied opportunities for exercise as well as companionship. Undoubtedly the humidity of cage and room should be controlled if the location is an unusually dry one, for the natural habitat of the gorilla certainly is one of relatively high humidity, and although its ability to endure a dry atmosphere has not been tested, it would be rash in the present state of our knowledge to assume that it can thrive irrespective of degree of humidity. Bedding of leaves, grass, excelsior, hay, should be supplied with proper precaution against dust or anything which might injure the skin or the respiratory or digestive organs. Cleanliness of quarters should be adequately provided for, and so also protection from pathogenic organisms carried by man and other animals.

We have spoken of the above as minimum requirements for the successful care of the captive gorilla, and we would now emphasize the fact that both the chimpanzee and orang-outan may be kept in health and contentment indefinitely with considerably less pains than these minimum requirements would entail. Hence we have presented these particular recommendations as applying especially to the gorilla.

CHAPTER THIRTY-FIVE

SOCIAL RELATIONS OF GORILLA

IS the gorilla gregarious, nomadic, sociable, dependent on its fellows, or the opposite? Is the social unit the family or the band? The information which we shall now present, entirely on authority, will suggest the answers to these and other questions of social relation, even although it does not justify an attitude of finality or dogmatism in statement.

THE SOCIAL UNIT

The classical reference on social relations is Savage and Wyman (1847, p. 423). From this we learn that the animals live in bands which are smaller than those of the chimpanzee. Usually the females are more numerous than the males. The authors affirm agreement among their informants, presumably natives, that each band has only one adult male. When young males achieve maturity a contest for mastery and leadership occurs and the victor becomes head of the band. Almost certainly Savage and Wyman depended exclusively on negro report for these facts.

The initial, often quoted statement of Du Chaillu apropos this subject is that the animal is not gregarious (1861, p. 349). Usually a male and a female, presumably mates, are found together. Occasionally a male wanders alone. The young form groups which establish their own camps for the night. In a subsequent publication (1867, p. 57) the author modifies his views by admitting that the animals are more gregarious than he had originally supposed and that bands numbering eight or ten individuals have been seen by him; that the natives also confirm this observation, and finally, that the animals tend to become solitary with age.

The monographs of I. Geoffroy-Saint-Hilaire (1858-61) and of Owen (1865) represent the observations of Savage and Wyman and of Du Chaillu without significant addition or constructive criticism. But in von Koppenfels (1877, p. 418) appear new observational materials. Except for "solitary hypochondriac males," the gorillas, we are informed, live in family groups, which because of the need of a large amount of food, wander within their range and spend the night wherever overtaken by it.

Almost the same words are employed by Hartmann (1885, p. 229) and Forbes (1894, II, 185) in characterizing the social unit in gorilla life. We quote the former: "The gorilla lives in a society consisting of male and female and their young of varying ages, and the family group inhabits the recesses of the forest." Evidently neither of these authors possessed more or different information from that provided by the observer von Koppenfels. Quite different by contrast is the case of Garner, for he, as will now appear, by the skilful combining of original observation, hearsay, surmise, and interpretation, presents an account which is novel if not entirely convincing. For fairness of presentation and as basis of critical comment, we quote:

> In the beginning of his career, in independent life, the gorilla selects a wife with whom he appears to sustain the conjugal relations thereafter, and preserves a certain degree of marital fidelity. From time to time he adopts a new wife, but does not discard the old one; in this manner he gathers around him a numerous family, consisting of his wives and their children. Each mother nurses and cares for her own young, but all of them grow up together as the children of one family. There is no doubt that the mother sometimes corrects and sometimes chastises her young, which suggests a vague idea of propriety. The father exercises the function of patriarch in the sense of a ruler, and the natives call him *ikomba njina*, which means gorilla king. To him the others all show a certain amount of deference. Whether this is due to fear or to respect, however, is not certain, but here is at least the first principle of dignity.
>
> The gorilla family, consisting of this one adult

male and a number of females and their young, are within themselves a nation. There do not appear to be any social relations between different families, but within the same household there is apparent harmony.

The gorilla is nomadic, and rarely ever spends two nights in the same place. Each family roams about in the bush from place to place in search of food, and wherever they may be when night comes on they select a place to sleep and retire. The largest family of gorillas that I have ever heard of was estimated to contain twenty members. But the usual number is not more than ten or twelve. The chimpanzee appears to go in larger groups than these, and sometimes in a single group two or even three adult males have been seen. When the young gorilla approaches the adult state, he leaves the family group, finds himself a mate, and sets out in the world for himself. I observed that, as a rule, when one gorilla was seen alone in the forest it was usually a young male, but nearly grown; it is probable that he was then in search of a wife. At other times two only are seen together, and in this event they are usually a pair of male and female, and generally young. Again, it sometimes occurs that three adults are seen with two or three children; often one of the children two or three years old, and the others a year younger, which would indicate that the male had had one of his wives much longer than the other. In large families young ones of all ages, from one year old to five or six years old, are seen; but the fact is plain that the older children are much fewer in number. I have once seen a large female with her babe, quite alone; whether she lived alone or was only absent for the moment I cannot tell.

The king gorilla does not provide food for his family, but, on the contrary, it is said they provide for him. I have been informed on two occasions, from different sources, that the king gorilla has been seen sitting quietly under the shade of a tree, eating, while the others collected and brought to him the food. I have never witnessed such a scene myself, but it does not seem probable that the same story would have come from two sources unless there was some foundation for it. (Garner, 1896, pp. 214-216.)

Further Garner asserts that the gorilla in the matter of government appears to be more advanced than most animals, that the male of the group leads on marches, selects feeding grounds and places to sleep, and determines the breaking of camp. There is seemingly a crude notion of justice and possibly also of right and wrong.

Of this description by Garner, Reichenow (1920, p. 15) remarks:

The observer does not tell us how he succeeded in obtaining this deep insight into the family life of the gorilla. Naturally his report can rest only upon the tales of the natives. What he presents to us is almost exactly the course of life of a rich negro.

With this critic we agree that Garner almost certainly transcended the results of trustworthy observation and indulged freely and rather uncritically in the unchecked report of hearsay and in interpretation.

There is an unusual degree of consistency among the reports of different authors and in turn as between them and the knowledge or beliefs of the natives, as thus summarily presented by Jenks (1911, p. 56):

The gorillas of Kamerun live in small companies, scarcely to be called families, except in the younger days of the band when only two, three, or four individuals are found together. A company seldom comprises more than twelve members, and is said never to exceed fifteen or sixteen. The smaller companies consist of one male with his one, two, or three wives, and some small children. A company of six or seven members would probably have two adult males. As the younger members grow up they take, or rather keep, their places in the company. When the old male becomes cross, or possibly, it may be, too infirm to travel with the company, he goes off by himself and spends the rest of his life without companionship. As to whether this isolation is from individual choice, or whether the females refuse to have more to do with the old male, or whether the young males band together and force his retirement, the natives do not agree.

Quoting from a letter of Zenker, Matschie (1904) confirms the occurrence of gorilla companies or bands, consisting of male, females, and young. The young males are reported as moving in advance, the females following, and the leader of the band bringing up the rear. This observational report is not particularly convincing, nor does it add importantly to prior knowledge.

From the frequency and arrangement of sleeping nests on the ground or in the trees von Oertzen (1913, pp. 4 ff.) is convinced that the number in a gorilla band or troop exceeds that of a single family. The herds are smaller than those of the chimpanzee. Isolated males occur and ordinarily frequent a narrow range (p. 5). Of sixteen nests found near together, nine were on the

ground and seven in trees. Reasoning that the number of nests probably exceeds the number of animals, since an individual may

Fig. 135. Seriousness of expression in young female *G. gorilla*. The look of distress is not a favorable sign. Courtesy New York Zoölogical Society, E. R. Sanborn, photographer.

in a spirit of trial or experiment build several nests, von Oertzen estimates the number of individuals in the band which occupied these nests as at least ten. We doubt the cogency of his logic or the adequacy of his naturalistic observation in relation to this estimate. So also does Reichenow (1920, p. 14), because his information indicates that the number of animals tends to exceed the number of nests, since the young seeking the protection of their parents or elders share their nests.

Under the title *Herd and Family Life,* Reichenow (1920, pp. 14 ff.) presents the best available critical discussion of the subject and the most considerable original contribution of fact. The social unit, according to this authority, is the herd, which in West Africa numbers from ten to twenty individuals and in East Africa, if available observations are trustworthy, may be somewhat larger, possibly twenty to thirty individuals.

That the social life of the gorilla could escape wholly or in part such good observers as Du Chaillu and Koppenfels can be understood from the fact that the animals do not usually stay together in a group during the day, but scatter over a fairly wide extent, so that the hunter usually runs across only one or two animals. Only towards evening do the gorillas gather together in order to sleep near together in their resting places. This probably accounts for the fact that in the southern forests where the location of the nests is variable, the separate families gather together less closely at night. The hunters also many times have had to do with the old solitary males which in the hunt are much easier to locate than the socially living animals. (Reichenow, 1920, pp. 15-16.)

It requires courage to defend the observational ability of the bitterly and traditionally discredited Du Chaillu. In part because of this fact, but chiefly because the more we have used his publications, the more deeply we have been impressed by the value of his observations, we support the preceding quotation with the comment that were Du Chaillu's descriptions stripped of

Fig. 136. Another view of a child gorilla. Courtesy New York Zoölogical Society, E. R. Sanborn, photographer.

ill-chosen adjectives and other cheap tricks to surprise and command the attention of the reader, they would stand as by far the

most important contribution to the natural history of the gorilla prior to the present century.

With von Oertzen, Reichenow agrees that the size of the typical gorilla band probably exceeds that of the family. Putting together his knowledge of the frequency and distribution of nests and the number of individuals observed together, he infers that the band may consist of as many as five associated families. Disagreeing radically with Famelart (1883, p. 152) that the sexes come together only during the "rutting" or mating season, Reichenow says:

With a single exception I have always found only two nests of grown animals near one another. The whole family is limited to these two nests. If a third or, exceptionally, a fourth nest is present, these are *much smaller* and belong to half-grown youngsters. Therefore we can draw the important conclusion that the gorilla is not polygamous, but lives monogamously, and that the sexes do not unite only during the rutting time, but remain together for several years. The half-grown animals continue apparently for a long time in the company of their elders, perhaps even until they found families of their own. (1920, p. 16.)

On a hunting expedition Reichenow had excellent opportunity to observe a gorilla family which consisted of adult male and female, a nearly grown male, which the observer shot, and possibly some younger animals. The group built two nests, one on the ground and another, a grass nest, on a tree trunk.

The fact that I met here one family *alone*, a circumstance which I have repeated several times, stands in contrast to what has been said above concerning the social life of the gorilla. If we consider that the company of gorillas during the day wanders far in their search for food, such an accidental find may be explained in that a family, separated from the others, did not join the main group for the night, but spent it alone, rejoining the others next day. The gorilla herd inhabiting that region in which the occurrences just described took place, I have seen many times, and have convinced myself that it consisted of a large number of individuals.

As stated, I have found only one exception to the rule that a group of nests holds two resting places for grown animals. In this case there were present seven nests which lay close together. Of these four belonged to grown and three to young animals. Obviously here two families had made their night camp together. That it might be a male gorilla with three wives seems to me improbable. If polygamy existed with the gorilla then we would oftener find three nests of grown animals in a family group. (1920, p. 18.)

In commenting on the nature and use of the bush nests as contrasted with the ground nests of the gorilla, Reichenow states that only one raised or bush nest is ordinarily found in a family camp. From this he infers that probably only one of the sexes, and that not invariably, constructs a bush nest. The natives say that the male of the family occupies this carefully made and comfortable nest. But with humor Reichenow observes:

This is again a case in which they carry over their own customs, for according to the habit of the negro to the man belongs the best place. It already has been shown that the raised nests present an exception to the relations which have been noted in the southern forests, where the females with their young make their resting place in a tree. Moreover, I have never found an isolated nest erected in this peculiar manner, and, according to experience, the solitary gorillas are always males. Therefore I have no doubt that the softly cushioned nests are built by female gorillas. And since they do not always undertake this painstaking work, we may well suppose that they do it only when they have sucklings. (1920, pp. 18-19.)

Reichenow's principal conclusions may thus be summarized. The gorilla family consists of male, female, and young. Families often associate to the number of as many as five, thus constituting bands which feed in the same general locality and camp together. But whereas the nests of a family are placed close together, a space of several yards may separate the sleeping places of one family group from those of another. The type of nest constructed depends on sex and the presence and age of young. Solitary males construct carelessly very crude ground nests. Adult males, with female and young, fashion their nests somewhat more carefully. The most securely built and most comfortable by far are the nests which Reichenow believes to be constructed by females with infants. Monogamy is to be inferred from the fact that the group of family nests consists ordinarily

of two of full size, with or without additional nests of smaller size belonging presumably to immature individuals.

The account of social relations appearing in Heck (1922) is decidedly inferior to that of Reichenow, since it is neither unified nor reasonably complete. The observations of Zenker, von Oertzen, and a few other authorities are cited, but the much more important materials obtained by Reichenow were not then available.

Concerning the social habits of the mountain varieties of gorilla we are informed by Arrhenius, through Lönnberg (1917, p. 17), that they live in bands numbering perhaps twenty to thirty individuals. These bands do not remain ordinarily more than a month in one locality because the supply of food becomes exhausted. No light is thrown by Arrhenius on the constitution of the family, its nature, or its relation to the band.

The social organization of the mountain gorilla, according to Bradley (1922, p. 133), appears to be the band rather than the family, for although the evidence is meager, there apparently may be more than one adult male in the group. Barns also (1922, p. 85) refers to a mountain gorilla troop as consisting of an adult male, which he shot, and two females with several immature individuals of various size. A second adult male was seen near the troop, but whether or not he was a member of the particular social group is not made clear. In a later publication Barns tell us, presumably on the basis of his own experience, that:

> A solitary male or "old-man" gorilla may sometimes be found alone, having been beaten and thrown out by a younger and stronger rival, but more often than not gorillas go about in small family parties of six or eight. Father and mother gorilla only will then make "nests" for themselves, whilst the others—young ones of different ages—will huddle around them to keep warm, the youngest of all sitting close to its mother's breast. I have never seen more than one fully adult male in a troop, but what appeared to be several fully grown females were usually present. (1923, p. 130.)

By contrast with such statements concerning mountain gorillas as we have cited or quoted, Akeley offers evidence and opinion which agree with those of Reichenow for lowland gorillas. More than one adult male may be found in a band or herd. In one instance he observed that "there were at least three old males, I think four, and perhaps a dozen females and youngsters" (1923, p. 235).

Akeley, erroneously we believe, states that Reichenow has made certain deductions about the family life of mountain gorillas, and after quoting that author states that his own observations do not corroborate the deductions. As far as we have been able to discover, Reichenow's observations and conclusions are limited to the lowland gorillas of the Cameroons and Gaboon. He disclaims personal knowledge of the mountain varieties and specifically indicates his sole reference to the lowland form.

> In one of the bands I saw [writes Akeley] there were three adult males. They might under his [Reichenow's] theory have been heads of three families. But in the other band there was but one male and several females. The extra females may have been spinster aunts of the family, but on the other hand, it might just as well have been a case of polygamy. The truth is that people know little about the habits of the gorilla. (1923, p. 247.)

Akeley's evidence for polygamy seems meager indeed, but so also is that of Reichenow for monogamy. Dogmatism evidently is not in order, and although we might tentatively accept the inference that the lowland gorillas are monogamous and the highland gorillas polygamous, it probably would be even wiser to admit the inadequacy of the evidence and face the problem as unsolved.

Certain additional and confirmatory evidence of social grouping in the mountain gorilla is supplied by Gyldenstolpe (1923, pp. 193-194). It is related that one large band, which was for some time observed, consisted by estimate of at least thirty individuals. When the group formed in line of march the females took the lead, the half-grown individuals came next, the small children next in order, and last of all the males.

We conclude this summary of observational data with a vivid picture of the social life of *G. beringei* by Burbridge (1928, pp. 253-254):

Leaving the trail, which led in another direction, we made our way cautiously downward through the indescribable confusion that littered the forest floor. From screening thickets we were soon watching a band of gorillas feeding in a bed of celery from which the forest fell away grudgingly, as though unwilling to give it the little sunlight that occasionally sifts through the ever-present gloom. We could see the gorillas appearing and disappearing among long juicy celery clusters eight feet tall. Presently a silver-backed male, a ponderous fellow with a mop of fur on the back of his head that rose above his shorter hair like a nightcap, walked toward the forest edge and made a peculiar chuckling sound. Several females with urchin-like young, some riding their babes upon their backs, joined him. Young males, much smaller than the great lord of the band, but scarcely distinguishable from the adult females, as their backs had not yet begun to turn to the peculiar silver yellow which is characteristic of the full-grown male, ambled from couches where they were resting. One mother, delayed by a truant youngster, cuffed it soundly before joining the others.

Gorillas are grave and deliberate in everything they do. The old man waited in quiet dignity until the band was assembled, then by gesture or word, I could not discern which, ordered them to march. With the gravity of a band of warriors they swung into line, females in the van, young following, the old male bringing up the rear. It was an imposing sight as they slowly disappeared in the forest.

MIGRATION

The migratory or nomadic tendency of both the lowland and the highland gorillas has several times been mentioned in our examination of gregariousness. There can be no doubt about the facts, but interesting questions concerning frequency, extent, and causes of migration arise. It is to be assumed from the facts presented by early as well as late observers that migration is determined primarily by food supply. For evidence the reader is referred to Du Chaillu (1861, p. 348; 1867, p. 59), Jenks (1911, p. 57), Lönnberg (1917, pp. 17-18), Gyldenstolpe (1923, p. 188), Sokolowsky (1908, p. 40). Von Oertzen (1913, p. 5) emphasizes the insularity of gorilla distribution, and from his account it may be inferred that each band lives in a certain definitely restricted area and within it wanders in accordance with the abundance and seasonal supply of food. The varying location and distribution of nests likewise, according to Reichenow (1920, pp. 20-21 ff.), definitely indicate continuous wandering.

To recur to the questions with which this chapter opened, we may now tentatively assert that the various species or varieties of gorilla are gregarious and nomadic; that the animals prefer association, and only exceptionally, as in the case of old males which have been driven from the herd, or possibly in some instances young males seeking to establish a family, live in isolation. Ordinarily the social unit is the band or herd, which may consist of several families.

SOCIABILITY AND FRIENDLINESS

The gregariousness of the gorilla implies a measure of sociability, but the habits and habitat of the animal render naturalistic observation of social relations extremely difficult, and little indeed is definitely known about this aspect of life in freedom. There are significant glimpses, yet because they are merely glimpses it is virtually impossible so to relate the phenomena that they constitute a connected account of social life. The fragmentary evidences exhibit the extreme importance of attention to the status of the animal as free or in captivity, its psychophysical condition as normal or disturbed, its sex, and perhaps most important of all, its age or stage of development. For certainly all social manifestations are dependent upon these variants.

It appears that although in the family group and band gorillas exhibit various forms of social relation, including, as we shall later indicate by description, friendliness and playfulness, they rarely if ever have social contacts with the chimpanzee. We refer of course to the free wild animals. The literature presents numerous statements that although gorilla and chimpanzee may live in the same region, they rarely

are observed in the same restricted locality and apparently do not intermingle. Descriptive statements of this sort might be cited for both lowland and highland gorilla. We refrain from citation because the only con-

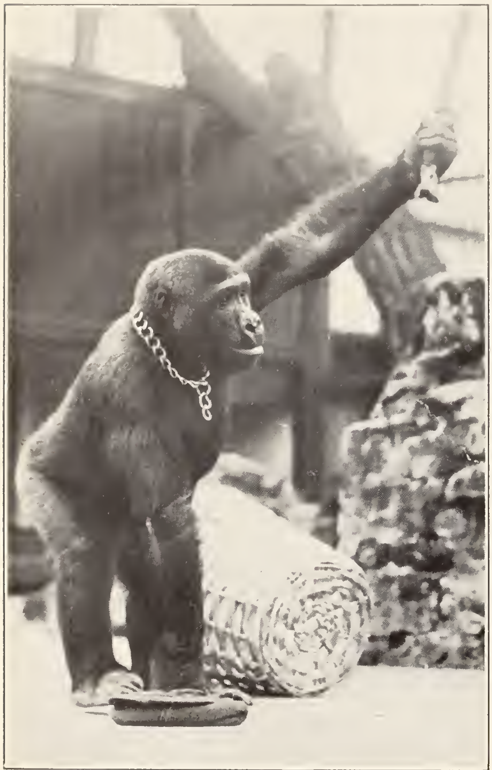


Fig. 137. Sultan (Cunningham gorilla) at play in the London Zoölogical Garden. Courtesy of F. W. Bond, photographer, and Zoölogical Society of London.

tradiction of the statement which we have made, as far as we know, is the seemingly unique experience of von Koppenfels which is thus described:

> When beyond the Aschangolo Mountains in the neighborhood of the Aschira land I shot a very strong male animal in a troop of chimpanzees which accidentally were eating cocoanuts peacefully with a family of gorillas, I privately suggested that I had shot the Kulu Hamba discovered by Du Chaillu, and mentioned the possibility that since the two species of Troglodytes had been met peacefully together, there might be here a foundation for hybridization. (1877, p. 418.)

Even this is not necessarily a discrepant observation because the individual referred to may very well have been a gorilla-like chimpanzee, as indeed the author admits in his mention of the "Kulu Hamba."

Of the attitude of captive gorillas toward chimpanzee companions, there are many and extremely varied accounts. From them one may prove that the gorilla is unfriendly or even hostile to chimpanzees, or, instead, the opposite. Thus for example Hermes describes a Berlin captive (1892, pp. 578 ff.) as seemingly morose and unsociable, but at times friendly and again hostile to a chimpanzee companion. And referring to the relations of a gorilla and chimpanzee, both young, kept for a time by him, Garner says (1896, p. 236) that the gorilla usually treated the chimpanzee as an inferior and with seeming contempt. (See also Sokolowsky, 1908, p. 47.) Instances of mutuality of interest and of consistent friendliness may be cited by contrast. We have recently had opportunity to observe entirely amicable and playful relations of a young gorilla and a young chimpanzee kept as cage-mates in the Philadelphia Zoölogical Garden, and, similarly, a pair of individuals of nearly the same age at the animal store of Henry Bartels, New York City. No simple description is adequate to this type of relationship. Aside from individuality and psychophysical condition, the age of the gorilla seemingly has most to do with its social attitude toward the chimpanzee. The younger the specimen, the more likely it is to be friendly.

The attitude of the wild gorilla toward man is also extremely variable and relatively unpredictable. Perhaps the best single contribution to the subject is that of Reichenow (1920, pp. 30 ff.). By him many circumstances which affect this form of relationship are mentioned. Among them are: the extent to which the gorilla has been hunted by man and in what manner; whether the appearance of the hunter is familiar, as in the case of the negro, or relatively unfamiliar, as is the white man. The animals may be curious, yet timid, as is indicated by many recent accounts of the behavior of the mountain gorilla, *G. be-*

ringei, in the presence of hunting parties, and in this instance, without indication of ferocity or hostility, it may approach, observe, and tentatively investigate the strange objects which have intruded upon its privacy. Or, again, reaction may indicate extreme fear and determined avoidance of the hunter, which if the male is wounded or cornered, or infant or child seized, may suddenly give place to rage and violent aggression. Solitary males, it is asserted by many observers, are far more likely to be dangerous to man because of aggressive hostility and relative fearlessness than are the members of a family or band.

In captivity the response of the individual to man is still more difficult of description because of its endless variations. Sex, age, previous experience, and the nature of human approach have much to do with the social attitude of the gorilla. Assuming kindly sympathetic treatment, the younger the specimen the more likely it is to respond in kind and promptly to become attached to and dependent upon its human friend or caretaker. But if brought into captivity as late in life as five years of age, there may be persistent resentment of human approach and extreme hostility. This it seems is much more likely to occur in the male than in the female. We have already referred in various connections to specimens which in captivity proved morose, savage, resentful of aggressions or even of companionship (see especially Milne-Edwards, 1884; Hermes, 1892; Grabowsky, 1904; Burbridge, 1928), and to sharply contrasted instances of extreme friendliness with persons on the part even of individuals captured at three to five years of age (see for example Falkenstein, 1879; Sokolowsky, 1908; Carpenter, 1917; Cunningham, 1921; Heck, 1922; Yerkes, 1927, 1927a, 1928).

Friendliness with other types of animal than the anthropoid apes or man is not uncommon in the captive gorilla. Dogs and monkeys are especially in point as partners in playful and mutually enjoyable companionship. But here again should we attempt a generalization we should expose ourselves to contradiction, for the type of companionship which proves agreeable to one little gorilla, or to it at a certain time, by another specimen or at another time may be rejected. Such terms as unpredictable, variable, capricious, reserved, are in order.

RESPONSE TO MIRROR IMAGE

Certain evidences of social interest appear in the responses of the captive gorilla to its mirror image, as they have been noted by several observers. We cite and quote the few references which have been discovered. Of these, as it happens, the first is an account of negative results, for Falkenstein (1876, p. 61) describes his small male captive as taking no notice of its reflection in a mirror, or of a young monkey which was at hand. Lack of interest, such as this statement indicates, raises suspicion of unfavorable psychophysical condition. Our suspicion is justified by the fact that other observers report keen interest. The behavior of the captive "Dinah" in the presence of a mirror Garner (1914, p. 1103) has described.

> To watch her movements and expression in searching for the gorilla behind a mirror is not only amusing, but is a study of animal psychics worthy of attention. With great caution she reaches her arm around the mirror and feels for the image. Not finding it, she peeps over, and under and around the sides of the glass. To her it is a strange elusive ape, and she has never become convinced that it is not a real gorilla. The interest, anxiety and disappointment in turn depicted in her black face are too human-like to be imagined on the visage of an ape, but she never tires of the futile search. Nothing else that she sees seems to interest and absorb her so profoundly as that mysteriously vanishing gorilla behind the mirror.

Similar to Garner's report is the following by Zeh (1915, p. 524):

> Keeper Engleholm has greatly interested her by showing her image in the mirror; with great caution she reaches her arm around the mirror and feels for the image; not finding it, she peeps over, under and around the sides of the glass. She never tires, seemingly, of the futile search of the mysterious gorilla behind the mirror.

The mountain gorilla Congo, observed by Yerkes, exhibited extreme and persistent in-

terest in her mirror image. Possibly this was because she lacked species companionship. Description of her initial response follows:

On my first opportunity, and with Congo in placid mood, I took the mirror into the cage. She

Fig. 138. Congo seeking contact with her mirror image. From Yerkes, Genetic Psychology Monographs.

was on the roof of her nest-room and did not come to me when I called her. But when I held up the mirror so that she could see its reflecting surface she quickly approached. Either she recognized the mirror as something of peculiar interest to her or she saw her image at a distance of six feet and was attracted by it. I held the mirror firmly upright on the ground before me. Congo approached and began to touch the glass with her fingers, hands, head, lips, and face. Then she pressed her lips against the image, apparently kissing it. She also tried to explore it with her tongue. After somewhat more than a minute, filled with such direct exploratory activities, she looked behind the mirror; then, returning to the front, she watched the image while reaching around behind the mirror with one arm and feeling and grasping for what she evidently assumed to be there. This type of performance was continued for between one and two minutes. I now placed the mirror on the floor of the porch of the cage where I could hold it more firmly and be more comfortable, while closely following Congo's behavior. As I attempted to move it from the middle of the cage toward the porch she clung to it tenaciously, evidently intent on keeping it within reach. It was almost pathetic to see her persistent search for the companion which she evidently felt must be near at hand. She simply would not give up the futile search. After some eight minutes of this behavior on Congo's part, I broke her hold on the mirror and removed it from the cage.

Peculiarly significant is the gorilla's tactual exploration and search where visual might have been expected to predominate. Important also are the degree of her persistence in examining the mirror image and in trying to locate its original, and her utter unwillingness to let the mirror go. (Yerkes, 1927, p. 147.)

PLAYFULNESS

The playfulness of the gorilla, chiefly a function of age, depends also on psychophysical condition. There are many references to its manifestations, but with very few exceptions they have to do with captive instead of wild specimens. We exhibit typical instances to illustrate varieties of description and also the nature of play.

The Falkenstein specimen is said to have been good-natured usually and playful. At times when energy abounded he would, as Falkenstein puts it, "probably in excess of well-being and out of pure pleasure," stand erect, beat his chest, or again clap his hands together, although this act had not been

Fig. 139. The young female mountain gorilla Congo kissing her mirror image. From Yerkes, Genetic Psychology Monographs.

taught, and perform crude dances in which he whirled around or staggered about as if intoxicated (1879, p. 152).

Interesting also is this summary of Garner's experience and his reference to modes of amusement or play:

> The gorilla is averse to human society. He is morose and sullen in captivity. He frets and pines for his liberty. His face appears to be incapable of expressing anything like a smile, but when in repose it is not repugnant. In anger his visage depicts the savage instincts of his nature. The one which lived with me for a time in the forest was a sober, solemn, stoical creature, and nothing could arouse in him a spirit of mirth. The only pastime he indulged in was turning somersaults. Almost every day, at intervals of an hour or so, he would stand up for a moment, then put his head upon the ground, turn over like a boy, rise to his feet again, and look at me as if expecting my applause. He would frequently repeat this act a dozen times or more, but never smiled or evinced any sign of pleasure. He was selfish, cruel, vindictive, and retiring. (1896, pp. 227-228.)

Although it is easy indeed to cite cases which obviously contradict the generalizations of Garner, we may not assume that they do more than indicate the serious risk of error in attempting general statement and emphasize the prevalence of extreme variability of behavior.

Garner himself refers to the specimen "Dinah" as a peculiarly good-natured animal who enjoyed tickling and was as ready for a romp as any tomboy.

> Her varied poses on the trapeze are quite unique, and some of them would arouse the envy of a professional acrobat. She often indulges in a game of solitaire football. She clutches a bunch of straw between her feet, and, using her arms as crutches, rushes across the floor of her long cage, tosses the wisp against the wall, then catches it in her hands and scuffles with it in a boisterous manner, as though it were some living thing trying to get away from her. After a bout or two at this she occasionally rises to an erect position and beats a rousing tattoo on her breast with her hands; striking alternately, with surprising rapidity and force. (Garner, 1914, p. 1103.)

Where playfulness is absent one may suspect malnutrition, disease, timidity, or an otherwise unfavorable psychophysiological condition. Notable illustrations are supplied by Falkenstein (1879) and Grabowsky (1904).

The statements of Falkenstein and Garner might be matched by quotations from several other authors who have had excellent observational opportunities. We mention especially Carpenter (1917), Cunningham (1921), and Yerkes, whose description of the play of a young captive mountain gorilla with dogs is quoted:

> Entirely consistent with Congo's limited imitativeness of human beings is her social independence. She is interested in persons mainly as sources of food or desired attentions. During my observation of her she paid relatively little attention to strangers, but I am told that her attitude has changed and that she now takes very considerable satisfaction in acting for the entertainment of a "gallery." To those of us who attended to her daily needs or studied her behavior she was consistently friendly, although as a rule not demonstratively so.
>
> Often, but not so frequently as one might expect, she was playful, sometimes making initial advances and at other times responding willingly to approaches. Similarly with her dog friends, Bobby and Betty, her moods and attitudes were variable. Occasionally she would play with them vigorously and until they were tired out or frightened off, but more often she gave them only passing notice or was so rough in her approaches that they quickly retired. Her play so far as observed by me was extremely simple, consisting of chasing or the reverse, climbing, a sort of hide and seek, and fist or foot cuffing. Because of her relatively great strength, romping with her was strenuous exercise and especially so because of her tendency to grasp and throw her whole weight on one, or climb upon and over and about one. Little originality or ingenuity was displayed in play activity, and I saw no indications of the invention of games or of any considerable variations from the simple activities already described. (Yerkes, 1927, pp. 145-146.)

This quotation mentions relatively small interest in persons. It is especially worthy of remark that the gorilla does not readily and eagerly perform or "act" for man's entertainment as does the chimpanzee. Whether this is because of timidity, lack of interest in human attention, or both, we do not know, but we suspect the former.

As our sole example of the natural play and other social relations of the free wild gorilla we quote at length the unique observation by Count Gyldenstolpe of the behavior of a band of mountain gorillas.

> We had not gone many steps before we found traces of a great herd of gorillas which had come

down into the valley from Karissimbi. The gorillas had not hurried—you would see that by the appearance of the tracks. On the way they had evidently been busy taking their breakfast, this time consisting of the juicy stalks of the chervil. Whilst taking specially great care not to make any noise, we crept cautiously forward. Soon we were near the gorillas. Now and then you could hear faint gruntings and movements and rustlings in the undergrowth announcing the presence of the animals. Unfortunately they themselves were completely hidden by the high vegetation. On the spot where the tracks had first been seen the greater part of my followers were left with strict orders to keep perfectly quiet and motionless, whatever happened.

I, my gun-bearer Simba and one of the guides crept forward slowly till we had reached the foot of a tree from which we could peep out over a small, fairly open place in the forest. In the middle of this opening lay a biggish tree thrown down, whose branches rose above the rich vegetation which everywhere covered the ground. My hiding-place was situated only about twenty yards from the place where the gorillas were. With very natural excitement I expected to catch sight of the animals any moment and perhaps behold a sight that few, if any, Europeans had had the luck to see. I had not long to wait before I caught sight of a baby gorilla slowly and cautiously climbing up the fallen tree trunk. This baby was soon followed by another, and the two young ones now began to play a clumsy game of "tick" with each other. Now and then they let themselves down on the ground. They never jumped straight down, but first hung by their arms, after which they threw themselves down on the ground with a thud and then after a short time got up on to the tree trunk again and continued the game afresh. Their movements were slow and very clumsy. Once when one of the young ones was trying to catch hold of its playfellow and made a violent movement it simply tumbled over, and in the surprise of seeing its playfellow disappear so suddenly the other one very nearly followed its example. Before it succeeded in regaining its equilibrium it took a real header.

On some occasions the young ones clasped each other in their arms and once I noticed how one of them, after an unsuccessful attempt to catch the other, began to beat the tree trunk with both hands, evidently in order to make its playfellow come nearer out of curiosity. Then suddenly there was a lively movement amongst the feeding animals and slowly and lazily a full-grown female gorilla climbed up the trunk. There she sat looking around. The young gorillas kept perfectly motionless for some moments. They resumed their dizzy game, however, as soon as the mother had convinced herself that no danger threatened. The female soon joined in the game, to the visible and audible delight of the young ones. Once I saw the female gorilla take one of the young ones in her arms. She remained sitting like that a long while, with the other young one jealously looking on. By and by the female climbed down to the ground again and the young ones continued their interrupted game alone.

A little further away there stood a dry tree, in the lower branches of which another female and a young one sat crouched, evidently no longer hungry, but content with their existence. To the left of me there was a fallen tree on which a big male sat on guard. Now and then he went down from his elevated post and broke off leaves and plants which, after he had carefully examined them, he put into his mouth with one hand and ate with a smacking sound. In the middle of the opening—unfortunately, however, completely hidden from my curious eyes—was the remainder of the herd, which, as appeared afterwards, consisted of about thirty members. Among them was the leader, who now and then made his presence known by a grunting sound. From time to time some short angry growls were heard from some gorilla who disputed with one of the others the possession of some specially delicate and juicy stalk, and sometimes we heard hollow sounds when one of them beat its bare chest. This habit of beating the chest seems to me to be a sort of signal of warning, or else it is to show their power and strength and to warn others to keep at a proper distance.

For more than half an hour I lay and enjoyed this rare and splendid sight of the gorillas' home-life in the wild forest. Unfortunately there was a drizzle that made photography impossible. (Gyldenstolpe, 1923, pp. 190-193.)

In summary and conclusion it may be said that although social behavior is obviously of extreme importance for our understanding of the nature and habits of life of the gorilla, little indeed is at present known with certainty, and that little represents mere fragments of the behavior of wild or captive specimens. Generalization is either impossible or extremely liable to error. In the light of the varied, yet meager and difficultly evaluated evidence, it appears that gorillas are decidedly less sociable among themselves, and also less friendly with other types of organism, than are chimpanzees. The descriptive terms hostile, morose, sullen, unsociable, although contradicted by the behavior of certain individuals, nevertheless seem applicable when attempt is made to contrast gorilla with chimpanzee or with man. But as our subsequent chapters

will indicate, we are far indeed from that adequacy of knowledge of this great ape which is essential to the understanding and interpretation of its behavior. What is now labeled sullenness, moroseness, or hostility, may eventually turn out to be a mixture of timidity and self-protection. We would emphasize especially the necessity for open-mindedness, avoidance of dogmatic statement, of generalization, and of too great emphasis on the importance of a particular observation or assemblage of observations. What we do not know about gorilla behavior is immense, even by comparison with what the literature makes it appear that we do know.

CHAPTER THIRTY-SIX

LIFE HISTORY OF GORILLA

Those forms of behavior which link generation with generation and constitute the story of reproduction are so incompletely and uncertainly known that it is quite impossible to give a satisfactory account of the life history of the gorilla. Of the phenomena of mating, oestrus, and reproduction we are surprisingly ignorant. Many of the statements found in the literature are based primarily on what is known of the other anthropoid apes and are therefore analogical inferences. In the following paragraphs we shall attempt to avoid such statements and to report only facts which rest upon direct observation. Because of the paucity of knowledge the account will necessarily be brief.

MATING

Direct information concerning phenomena of adornment, courtship, mating, and other distinctively sexual or sex differentiating activities is almost wholly lacking. Such casual references as occur for example in Reade (1864), Burton (1876), Pechuël-Loesche (1882), Famelart (1883), and Garner (1896) are representative and possess almost no scientific value. Even seasonal mating is not definitely established by the literature, for although Famelart (1883, p. 152) asserts that there is a rutting season during which the male calls the females and for a time remains with them and defends them in case of aggression, Reichenow (1920, pp. 15 ff.) rejects his statements and offers evidence that the gorilla is monogamous and that mates remain together throughout the year and indefinitely. Evidence and opinion alike favor Reichenow's contention that pairing is relatively permanent, but monogamy is not definitely established. Indeed, Garner (1896) and Akeley (1923) suspect that polygamy is prevalent.

REPRODUCTION

Except for a few behavioral observations and some excellent morphological descriptions of the gorilla fetus at various stages, the generative process remains unknown. As recently as 1899 (p. 298) Keith, from inclusive and intimate knowledge of the anthropoid literature, wrote: "Of menstruation in the Gorilla, nothing is known." The oestrus cycle naturally cannot be observed satisfactorily in the free wild gorilla. Hence no information can be gleaned from the reports of travelers, explorers, hunters, collectors, and other observers who incidentally, and commonly from memory instead of from reliable field notes, describe aspects of gorilla behavior. As far as we have been able to discover, at the time of writing Keith's statement was justified, and it stands today, as far as the wild gorilla is concerned.

Of gorillas in captivity we have knowledge of only two which during period of observation passed from childhood into adolescence and possibly through the period of puberty. The one is the Breslau gorilla "Pussi" described by Grabowsky; the other, the Burbridge specimen "Congo," described by Yerkes. Each in this particular connection is worthy of special description.

"Pussi" on arrival in Germany in September, 1897, weighed thirty-one and one-half pounds and was estimated to be four years of age. According to Grabowsky (1904, p. 254; 1906, p. 610) signs of sexual excitement were first noticed in July, 1898; they recurred in September, and from January, 1899, they appeared fairly regularly and at intervals of about four weeks. Presumably physiological test of the sexual condition of the animal was not made and consequently it remains uncertain whether oestrus actually occurred or whether the periodic indica-

tions of sexual excitement preceded sexual maturity. Critical comment concerning this case is especially in point.

At times this excitement lasted only a day, at times several days. The dark brown eyes of the animal, which usually had a very quiet, gentle, somewhat shy expression, took on a staring wild look. During this time of sexual excitement—for so I might designate this condition—whenever a male person known to the animal came into the ape house, she would stand with her hind legs far apart, support herself in front upon her left hand, and strike herself with the flat or closed right hand between her legs against the sexual parts in quick tempo, until that special person had disappeared, or had threatened her with the whip, which, however, only helped for a short time. The animal never gave utterance to any sounds during this extraordinary performance, she rather pressed her lips close together during the striking, and held high her head which usually was hanging down. In these days of lust her appetite was usually a little weaker. Bleeding from the vagina was not observed; whether some flecks of blood which appeared in the bed Sept. 16, 1903, came from such bleeding, could not be determined with certainty. (Grabowsky, 1906, pp. 610-611.)

Fig. 140. An infant gorilla (*G. gorilla*), aged one month, with foster nurse in Africa. Courtesy of E. Reichenow.

There is adequate ground for believing that the female chimpanzee does not ordinarily achieve sexual maturity short of about eight years. It is improbable that the gorilla develops more readily than does the chimpanzee. From this we may infer either (1) that Pussi was above the estimated age of five years when periodic sexual excitement was first manifest, or (2) that as a pre-adolescent she exhibited from time to time what was taken for sexual behavior. It seems to us almost equally probable that she was a stunted specimen, older than the observers thought, or that, whatever her age, she exhibited sexual behavior prior to adolescence. Unfortunately, and we might even say inexcusably, Grabowsky fails to offer adequate description of the behavior which he designates as signs of sexual excitement. For this reason his account is of uncertain value, and it is extremely doubtful whether it may be accepted as proof of the existence of menstruation.

From the observations of Yerkes (1927, 1927a, 1928) it appears that the specimen of *G. beringei* "Congo," at an estimated age of five years, weighed sixty-five pounds. At this age she exhibited no behavior which was clearly indicative of sex interest or sex excitement. One year later she had doubled in weight, and although no indications of menstruation or of periodic sexual interest or excitement were noted, she occasionally manifested sexual behavior toward other animals. The following is descriptive of such behavior toward a dog playmate.

The really notable thing, and the primary excuse for this account of Congo's social relations with the dogs, is the evidence of developmental change afforded by what presumably should be designated as sex play. In 1926 almost nothing suggestive of sex interest in other animals in her environment and no form of sex play was observed; therefore the peculiar and very considerable genetic interest of the following data.

On January 19, 1927, while Congo was chained to her oak tree, both Betty and the mongrel male, which we shall for convenience designate as collie, were at hand, and although the latter was timid

and stand-offish, Congo succeeded in getting hold of him and drawing him to her. I happened to be watching closely and I noticed that she appeared to be unusually gentle and considerate of his feelings. This I at first inferred to be caution on her part lest he bite her. Having drawn him within reach she in a calm leisurely way proceeded to examine him, smelling his face, legs, body, the while also using her eyes. Then, the dog remaining passive, she raised one hind leg and turning him on his side exposed the genitalia. There followed manual, olfactory, and visual examination. Her attitude and expression were indicative of interest and perplexity. She acted slowly, as if puzzled by the new sense data. Again she explored his head, legs, and body, and then returned to the genitalia. Once the dog attempted to draw away from her, but she held him firmly and gently. Now pulling the animal toward her she turned him on his back and stepping astride assumed a male copulatory position and executed appropriate movements. This persisted for a few seconds, when stepping from above the dog she threw herself on her back and drew him, belly down, upon her. Thus she held him for a few seconds in what had every appearance of sex embrace. The dog however, instead of coöperating or remaining passive, made vigorous efforts to escape.

This behavior is similar to what is definitely recognized as sex play in young chimpanzees. Whether it is legitimate to designate Congo's reaction to the collie as sex behavior is uncertain. But in any event, nothing like it was observed during the winter of 1926 and it presumably indicates developmental change. (1927a, pp. 520-521.)

When a year later Congo was presumably seven years old and weighed approximately one hundred and sixty pounds, sexual behavior was more definite and frequently exhibited. Periodicity of such behavior, or indeed of any indications of sexual excitement, was not noted, but circumstances of observation were such that even although present it might not have been discovered. The nature of the animal's behavior at this time suggested the nearness of sexual maturity, and anticipating the appearance of menstruation effort was made to discover initial evidences (Yerkes, 1928, p. 78).

In this perfectly healthy, vigorous, and rapidly growing captive, menstruation apparently had not begun even when she weighed several times as much as did Pussi when the latter, according to Grabowsky, exhibited periodic sexual excitement. We hazard the inference from the behavior of Congo and from the lack of any signs of turgescence of the external genitalia, that she had not achieved sexual maturity when last observed by Yerkes. This inference, based primarily on behavior, was confirmed in April, 1928, when Congo came to autopsy, for Dr. Joseph Halton, of Sarasota, Florida, reported to us that the reproductive organs, in his opinion, were immature. How much weight may safely be placed on this structural evidence in the absence of comparative materials is uncertain.

The literature does not disprove the occurrence of menstruation in the gorilla; neither does it supply dependable evidence of the phenomenon, definite description of its appearances, and of its periodicity. We therefore must conclude that although menstruation doubtless occurs in gorilla, as in the other anthropoid apes, the fact has not been observationally established.

The period of prenatal development or gestation is undetermined. The literature contains certain pertinent but inconclusive information. Most of it has been brought together by Schultz (1927) in his recent report on growth of the gorilla. As a matter of convenience to the reader, because of the probable inaccessibility of the publication, we quote from this authority.

Bolk (1926) assumes that gestation in gorilla is shorter than in man, since the former weighs at birth considerably less than the latter. However, the size of the fetus at term is among different primates apparently not correlated with the duration of their intra-uterine growth. . . . Reichenow (1921) captured a gorilla baby, only a few days old, which weighed two kilograms [approximately 4.4 pounds]. . . .

Body weight varies very considerably at any age in man and, apparently, also in gorilla. For instance, the male gorilla baby, captured by Famelart, was in this author's opinion about seven months old, yet it weighed only two kilograms, *i.e.*, as much as Reichenow's new-born. Of course, the above estimate of age may be too high, but the animal must have been at least two months old, since two incisors had erupted in the upper jaw and four in the lower jaw. Akeley [1923, p. 245] gives the following interesting quotation from a letter by an English hunter: ". . . shot a female [Mountain Gorilla] with a young one in her arms. . . . The baby was apparently not more than 24 hours old. . . . The baby gorilla (a female) is

now two months old and in the best of health and weighs nine pounds. She has cut six teeth. She does not show any signs of walking yet. . . ." (Schultz, 1927, pp. 15-16.)

Fig. 141. The Reichenow gorilla, aged two months. Courtesy of E. Reichenow.

The literature affords no indication that the gestational period has ever been reliably observed. The few statements available are clearly inferences or surmises. If we are to reason from the almost equally unsatisfactory data available for the other anthropoid apes, we may state that the period probably is not less than seven nor more than nine months. Although the evidence cited by Schultz would make it appear that the gorilla at birth may weigh as little as two or three pounds, comparative study of the evidences, both direct and indirect, convinces us that it more likely is somewhat heavier and that growth after birth is very rapid.

Parturition apparently has never been observed in the gorilla, or if observed the literature contains no record of the fact. Presumably normal reproduction has not occurred in this ape while in captivity. Certainly there are no records of mature specimens living in healthful captivity outside of Africa, much less of attempts to mate the animals. Although it is not improbable that births have occurred in case of specimens held captive in Africa or on shipboard, we are unable to establish the fact by citation of authority. Evidently captive conditions are highly unfavorable to reproductive activities and it would be rash to predict that this interesting manlike ape can be successfully bred in other than its natural habitat and in complete freedom. Nevertheless we expect success.

Mention is occasionally noted of single

Fig. 142. The Reichenow gorilla, aged five months. Courtesy of E. Reichenow.

births, but we have discovered no reason to believe that such statements are based on direct evidence. Apparently it is assumed,

and doubtless this is reasonably well substantiated by native report (Jenks, 1911, p. 57) and naturalistic observation, that single birth is typical. Although evidence of multiple births is lacking, it may not be asserted that they never occur.

To summarize briefly the status of our knowledge of gorilla reproduction, it may be said that menstruation has not been definitely established, the oestrus cycle has not been studied, the period of gestation is unknown, as is also the course of prenatal development and the nature and conditions of birth or parturition. The weight of the newborn is a matter of inference and surmise. Evidently there is interesting and important opportunity for the student of behavior and of physiological process in the life history of the gorilla.

RELATIONS OF PARENT AND YOUNG

An unexampled picture of family life is that drawn by Count Gyldenstolpe, as quoted from the book of Prince Wilhelm of Sweden, on our pages 439-440. Among the few other observers who have contributed significantly to this aspect of gorilla life history are Du Chaillu, von Koppenfels, Garner, and Reichenow. From the experience of these observers we shall attempt further to illustrate typical aspects of the relation of parent to young.

> We were walking along in silence [reports Du Chaillu] when I heard a cry, and presently saw before me a female gorilla, with a tiny baby-gorilla hanging to her breast and sucking. The mother was stroking the little one, and looking fondly down at it; and the scene was so pretty and touching that I held my fire, and considered—like a soft-hearted fellow—whether I had not better leave them in peace. Before I could make up my mind, however, my hunter fired and killed the mother, who fell without a struggle.
>
> The mother fell, but the baby clung to her, and, with pitiful cries, endeavoured to attract her attention. I came up, and when it saw me it hid its poor little head in its mother's breast. It could neither walk nor bite, so we could easily manage it; and I carried it, while the men bore the mother on a pole. When we got to the village another scene ensued. The men put the body down, and I set the little fellow near. As soon as he saw his mother he crawled to her and threw himself on her breast. He did not find his accustomed nourishment, and I saw that he perceived something was the matter with the old one. He crawled over her body, smelt at it, and gave utterance, from time to time, to a plaintive cry, "Hoo, hoo, hoo," which touched my heart.
>
> I could get no milk for this poor little fellow, who could not eat, and consequently died on the third day after he was caught. He seemed more docile than the other I had, for he already recognized my voice, and would try to hurry towards me when he saw me. (1861, p. 244.)

Additional descriptions of the attitude and behavior of the infant gorilla toward the mother appear in Du Chaillu (1861, pp. 260-261, 352).

The following we take from von Koppenfels (1877, p. 419):

> Hiding behind the trunk I watched there a gorilla family which was carelessly busy with fruits. This consisted of both parents and two youngsters of different ages; measured by human age the older may have been six years, the younger one year old. Although the animals were within reach of my double-barrelled gun I determined, since I was completely hidden from them and could observe them unnoticed, to watch their behavior for a while. It was touching to see with what mother-love the female gorilla cared for the youngsters. The father, on the other hand, did not trouble himself about them, but only satisfied his own hunger. The better fruits must have been eaten when the female gorilla, with extraordinary agility, climbed the trunk and shook down the ripe fruits.

Garner takes particular pains to contradict previous report that the infant gorilla is carried clinging to the abdomen of the mother.

> I have seen the mother in the forest with her young mounted upon her back, with its arms around her neck and its feet hooked in her armpits. I have never seen the male carry the young, but in a number of specimens of advanced age I have seen a mark upon the back and sides which indicates that he does so. (1896, p. 227.)

There are in fact several accounts in the literature of the pickaback relationship, but few mentions of the breast to breast position of infant and mother during locomotion. Nevertheless, we believe that the evidence indicates variation in both directions, and that probably the younger the infant the more likely it is to cling to the mother's

breast or abdomen. Until the infant becomes independent the mother carries it with her much of the time, "clasping her arm around it. She picks the child up by one arm, often cradling it in her two arms as the human mother does her child. The natives note in this conduct one of the gorilla's greatest likenesses to man." (Jenks, 1911, p. 57.)

Fig. 143. Another view of the Reichenow gorilla, aged five months. Courtesy of E. Reichenow.

An instance of parental solicitude and protection is presented by Aschemeier (1921, p. 91):

On two occasions I captured young chimpanzees, but only once did I come near to getting a young gorilla alive. In this case a mother gorilla strayed a bit farther than usual while the baby was feeding. We had heard the animals in the bush, and were advancing cautiously when we saw the young one on the ground. We were closing in to capture it when suddenly we heard, on both sides, the swishing of bushes. Both parents were coming to the rescue as fast as they could. The smaller, presumably a female, went straight to the youngster, picked it up, and stood looking us full in the face. The old male arrived near these two very quickly, and on seeing us gave the terrible gorilla cry, and started off in the lead. As we followed, he dropped to the rear to guard the mother and young. This was one of several times, when the parents showed signs of willingness to sacrifice their own lives for the young, that I did not shoot.

The incident described by Aschemeier appears to be typical, and there is sufficient ground for asserting that parental solicitude, sympathetic care, and protectiveness are constantly exhibited. The female, it may be inferred from the bits of evidence available, normally attends to the cleanliness and feeding of the infant in typical primate fashion, carries it about with her in some such manner as indicated by the authorities quoted, encourages creeping, although there apparently are no direct observations to support this statement, and assists it in learning to walk and climb. There are no instances of definite tuitional effort, but the suggestion contained in such meager descriptions as are available is that the parental activities of the gorilla include definite direction of the young. How long the infant continues to nurse is unknown, as are also

Fig. 144. The Reichenow gorilla (right), aged seven months, with an infant chimpanzee. Courtesy of E. Reichenow.

the nature and development of early social responses, protective acts (offensive and defensive), nest building, and the acquisition of feeding habits. Unquestionably it is of peculiar interest to discover the respective contributions of structure and experience to such forms of behavior.

Where one might naturally have expected, perhaps even assumed, an abundance of information, appears instead an array of unsolved and in many instances untouched problems.

INFANCY AND CHILDHOOD

CONCERNING the characteristics of gorilla infancy and childhood almost nothing can be learned from the records of the life of the wild gorilla. Captives, however, are usually either infants or children when taken and during their existence in confinement. Hence there are many characterizations of individual specimens in these stages of life, but strange to say, with the possible exception of the account of the Burbridge gorilla Congo, there is not a single systematic description and there is entirely inadequate material for generalization.

The dominant traits of infancy are dependence, trustfulness, and apparently sympathetic or affectionate attachment. In the illustrative accounts of infantile traits which we purpose to use there are many inconsistencies and contradictions. These we believe truly represent species, sex, and individual variations as well as expressions of different psychophysical conditions and the influence of diverse modes of handling.

Even in its infancy the gorilla is pictured by Du Chaillu as hostile to man, vicious, and untamable. It is an interesting question whether this observer's attitude toward his animals elicited unfriendly response or whether he chanced upon individuals of disagreeable temperament. Of course there is also the possibility that his descriptions are overdrawn. At any rate, they disagree with those of most other authors. Famelart (1883, pp. 149-150), for example, tells of the infantile behavior of a specimen which promptly became attached to him, cried like a human infant when he left it, and embraced him on his return. Essentially similar are the characterizations of infantile specimens to be found in Garner (1896), Sokolowsky (1908), and von Oertzen (1913, p. 8), who says: "A gorilla baby reminds one extraordinarily of a human being, with its round head, lively glancing eyes, small ears, and the mobile play of countenance."

As unusually important we quote Reichenow's description of an infant.

> The young gorilla which came into my possession and to which I gave the name Adán, was when captured, judging by his navel recently covered with hair, some two weeks or so of age. His length, from the tip of his head to the soles of his feet measured 44 centimeters; from the tip of his head to the coccyx, 30 centimeters; and his weight was exactly 2 kilograms. According to observations made in the human infant—which immediately after birth suffers a diminution of weight and then recuperates during the first two weeks—we may surmise that the said weight corresponded pretty nearly to the initial weight. The newly born gorilla must weigh, therefore, notably less than the recently born child (about 3.35 kilograms), which is worthy of mention because the weight of the adult gorilla greatly exceeds the normal weight of man.
>
> Adán developed perfectly until he was ten months old, when he fell ill because of the change in climate in transporting him from the territory of the jungle to the region of the prairies and to a very elevated part of the country. He died soon after. At the age of ten months he measured from the tip of the head to the soles of the feet 60 centimeters, from the tip of the head to the coccyx, 405 millimeters, and weighed 5.75 kilograms.
>
> At the beginning of the observation his skin was a hazel color; . . . shows us that Adán is notably lighter than his nurse, who was chocolate colored. Nevertheless the skin rapidly turned darker and at the age of three months it was almost completely black.
>
> At first all of his body was covered only by scanty, short, black hair, so that the skin was everywhere visible to the sight. It is notable also that his forehead had no hair, but on the upper part of the head there arose a tuft of long hair of a brownish black color. . . . At the age of two months . . . the hair had thickened noticeably all over the body and was quite heavy, especially on the backs of the arms and legs. During the third month he began to have hair on the face also, on the cheeks and chin and also on the fore-

head. Then the large tuft of hair on the top of the head began to drop out little by little, being replaced by short black hair which commenced very close to the superciliary arches. At the age of five months the change of hair was completed. . . .

Fig. 145. The Reichenow gorilla, aged seven and one-half months, walking. Courtesy of E. Reichenow.

The development of the teeth was promptly effected. Scarcely had he reached the age of two months when the first incisors broke through the gums of the lower jaw, and two weeks later those of the upper. Toward the end of the sixth month the first molar appeared. The coming of new teeth was always announced by the fact that Adán rubbed his gums a great deal with his thumb. . . .

With reference to his intellectual development, it was observed that Adán at the age of some three and a half weeks began to react to the sound of strange noises by turning his head. At eight weeks he could manifestly fixate, and would follow a moving object with his eyes.

The faculty of distinguishing could be observed toward the end of the third month when he began to extend his hands toward the nursing bottle as soon as it appeared in his field of vision, but not until he was seven months old did he succeed in distinguishing persons.

At five months Adán began to sit up by himself and would remain seated a long time. At the same time the first attempts at locomotion began. Adán would stretch out his arm and grasp objects, and draw himself toward those which remained fastened by bending his arm. In the seventh month his first attempts to stand on his feet were successful provided he could catch at some support with his hands.

The development of the faculty of walking came toward the eighth month. . . . On beginning to walk he doubled his knees so much that his rump almost touched the ground and he supported himself on the palms of his hands. Then he began to double the last two knuckles of the hands while the rest of the palm still touched the ground. . . . Some days after he began to place the palms of the hands in contact with the ground in such a manner that in walking the back of the fingers served as a point of support, as is customary in the adult animal. At the same time that he began to walk he developed the ability to climb. (Reichenow, 1921, pp. 345-347.)

From a few brief opportunities to observe gorillas during the first two years of life we are able to confirm the manifestation of dependence, friendliness, and attachment to human friend and caretaker.

The conspicuous traits of childhood are: rapidly increasing independence, playfulness, boisterousness, manipulation of objects for exercise, amusement, and sound production, as by rattling, beating, and pounding, appearance of social aggressiveness, friendliness, and coöperativeness or the reverse, according to circumstances.

Illustrative of the behavioral characteristics of gorilla childhood are such descriptions, based exclusively upon observation of captive specimens, as are provided by

Fig. 146. The Reichenow gorilla, aged seven and one-half months, running. Courtesy of E. Reichenow.

Falkenstein, Garner, Sokolowsky, Heck, Carpenter, Cunningham, and Yerkes. In the foregoing chapters and sections we have already sufficiently described the behavior of notable captives to render unnecessary at this point more than summary statement. That the descriptions vary extremely is not surprising, for the evidence is convincing that several of the individuals in point were unusual or even pathological because of improper care, malnutrition, or disease. When one adds to these unfavorable circumstances the possibilities of temperamental variations, there is adequate explanation of the variation from hostility and maliciousness to friendly affection, from suspicion and treachery to confidence and frankness.

Fig. 147. The infant gorilla Bamboo, playing with a ball in the Philadelphia Zoölogical Garden. From a motion picture film by the authors.

Particularly worthy of remark are the recurring statements that the gorilla child often, if not as a rule, is sensitive to reproof on the part of friendly caretaker, obedient even if also wilful, observant, and deliberate. Especially illuminating on such matters are the experiences of Cunningham, which unfortunately are incompletely and inadequately recorded in print, and those of Burbridge and Yerkes. Doubtless the most nearly complete psychobiological description of gorilla childhood is that based by Yerkes on his observation of the young mountain gorilla Congo.

ADOLESCENCE

We have already had occasion to remark that adolescent gorillas have seldom been held long in captivity. This doubtless is because the older the animal when captured, the more strenuously it resists and resents captive existence and consequently the more likely it is to succumb quickly to the unfavorable circumstances. Numerous instances of the capture of half-grown specimens are recorded, but of psychobiological observations on adolescents there are only a very few, and some of those are possibly referable to childhood, since the age of the specimen or its degree of maturity may have been overestimated.

Once more we cite the Grabowsky specimen "Pussi," which we can but consider either a seriously stunted individual or a dwarf. To draw from it a picture of gorilla adolescence would, we are sure, be entirely indefensible.

The account by Reichenow of an adolescent male which he shot in its family group is of interest as affording evidence of the continuing sympathetic relation between parent and offspring. It is related by this author (1920, p. 17) that the partially grown animal, which he infers to be the son of two adults with which it was in company, was shot and wounded by him one evening. The following morning he discovered its dead body near the nests of the adults. Apparently it had been dragged thither.

The Burbridge specimen "Congo," according to the surmise of Yerkes, was nearly sexually mature at her death. She may with assurance be described as adolescent. This conclusion, however, is contradicted by Burbridge, who expressed the following surmise:

> She is a Kivu gorilla, which is the largest of the species. They probably reach puberty at twelve or fifteen years of age. Adult males attain a weight of some four hundred and fifty pounds, females approximate fifty or one hundred pounds less in

avoirdupois. Miss Congo is now about eight years old, in robust health, and will soon tip the scales at two hundred pounds. (Burbridge, 1928, p. 287.)

To say that we are ignorant of the psychobiological traits characteristic of gorilla adolescence would be very nearly the exact truth. Yet from such pictures as Burbridge gives of his experience in capturing and attempting to tame a young and presumably pre-adolescent male called "Bula Matadi" (1928, pp. 256 ff.) one obtains vivid impression of the degree of independence, courage, and power in defense of which the animal is capable. We reserve for a later chapter, as illustrative of anger and rage, Burbridge's graphic account of his experience with this young male (see p. 469).

GROWTH

What is definitely known concerning rate of growth and the age at which various important and critical stages of development are achieved by the gorilla may be told in very few words. The average weight at birth is unknown. Authorities encourage one to hazard the guess that it may be as little as two pounds or as much as six. Records of the weight of captives are few and very nearly valueless because the age and condition of the specimen with respect to nutritional normality and approach to average size are not definitely known. Furthermore, many observations reported are estimates instead of reliable measurements. For what they are worth, and in most instances it is little indeed on account of the defects which we have pointed out, we present the following data and supplement them by references to the best sources of information concerning the nature and progress of physical growth in the gorilla.

"Pussi," as reported by Grabowsky (1904), in September, 1897, at estimated age of 4 years, weighed 31½ pounds; in August, 1904, she weighed 66 pounds. In approximately seven years she barely more than doubled her weight. The data of Reichenow (1921) we have presented on page 448.

The male gorilla, according to Friedenthal (1914, p. 74), may attain a weight of 440 pounds. This authority gives as weights per year of age: 4 years, 35 pounds; 5 years, 42 pounds; 6 years, 57 pounds; 7 years, 66 pounds; 8 years, 73 pounds. These estimates refer presumably to the lowland gorilla.

The Dublin captive "Empress," supposedly between one and two years of age when received in Ireland, is reported (Carpenter, 1917) 3 years 4 months later, when approximately 5 years of age as weighing 31 pounds. This record is similar, it should be noted, to that of the specimen "Pussi."

The Cunningham specimen "John Daniel," at estimated age of two to three years, weighed in December, 1918, 32 pounds; in March, 1921, he stood 40½ inches high and weighed 112 pounds. In approximately 2 years 4 months he had gained 80 pounds (1921, p. 118). This also, like the specimens "Pussi" and "Empress," was a lowland gorilla. Either the growth in this case was of abnormal rapidity, or that of the other specimens was unusually slow.

For the mountain gorilla Congo the observations of Yerkes (1928, p. 5), made at intervals of a year, appear below:

	January, 1926	*January, 1927*	*February, 1928*
Weight	65 pounds	128 pounds	160 pounds
Standing height	38 inches	47 inches	50 inches
Sitting height	25 inches	....	32 inches
Chest girth	34 inches	....	42 inches
Arm span	60 inches	....	74 inches
Circumference of wrist	7 inches	9 inches	9.3 inches
Length of foot	8 inches	9.5 inches	9.5 inches
Maximum reach with one arm (both feet on ground)	58 inches	70 inches	75 inches

Fig. 148. Portrait of infant male *G. gorilla* Bamboo, estimated age two years. Photograph by Newton Hartman, courtesy of Philadelphia Zoölogical Garden.

These data, although measurements were made as carefully as was possible under the circumstances, are not highly accurate. Doubtless, however, the weights are reliable within three to five pounds. It is significant, indeed, of startling differences or the mis-

leading character of other observations that Congo should have gained so rapidly during her two and one-half years of captive life, progressing from initial weight of 65 pounds to 128 a year later and 160 after another year.

We have certain observations on specimens of lowland gorilla estimated to be one to two years old which indicate weights varying from twelve to eighteen pounds, but of course the uncertainty about age renders the data of slight value.

There is no adequate basis for estimating the age at which the gorilla becomes sexually mature, the age at which maximal growth is achieved, or the changes in physical measurement which are correlated with the progress of senility.

Readers who desire to follow this subject further and to acquaint themselves thoroughly with the anthropometric and related data which are available will find especially helpful the recent monograph of Schultz (1927), with its extensive bibliography, and in addition such publications as those of Deniker (1891), Keith (1899), Mollison (1910-11), Friedenthal (1914), Lönnberg (1917), and Sonntag (1924).

MATURITY, SENILITY, AND SPAN OF LIFE

With advancing age, the gorilla comes to take life with increasing seriousness. Playfulness first disappears and subsequently activity becomes reduced to the minimum essential to survival. Nowhere can one find a satisfactory psychobiological account of either maturity or senility. As in case of all other periods of life there are available glimpses of an individual, usually of unknown age, often of unknown sex and species, and it is only by bringing together such fragments of description that one may obtain a general picture. We have chosen to leave to the reader this task of composition. Throughout our chapters we have cited contributory evidences. That they are contradictory is unfortunate but not necessarily unfaithful to the facts of nature.

Many authorities have stated that as the male gorilla ages, the hair, especially on the back, becomes lighter, and a few authorities assert that extremely old males sometimes are so light in color that they are described as white and might readily be mistaken for albinos. Almost certainly this change in coloration is correlated with age as well as with sex, for although the coat color of the female is known also to vary more or less during development, and possibly also seasonally, there seems to be no such striking change as that commonly observed in the male, where the adult is often characterized because of the white band across the back as a grayback. According to Reichenow (1920, p. 19) the white or very light colored males are usually solitary individuals.

As to span of life, basis for definite statement or even for estimate appears to be lacking. The evidences concerning rate of growth and probable age at which maturity and maximal growth are achieved suggest conditions comparable with those in man, but we may not safely infer from this that the span of life in the gorilla is similar to the human. However, this obviously is the choice of several authors who have referred to the subject.

Apropos of this subject, as well as of span of life, we quote Du Chaillu:

> Aged gorillas, the negroes told me, turn quite gray all over; and I have one huge male in my collection whose worn-out tusks show great age, and whose colour is, in fact, a dirty gray, with the exception of the long black shaggy hair on the arm. The head is covered with reddish-brown hair, short, and extending almost to the neck, or where the neck should be. (1861, p. 355.)

In Bradley (1922, p. 133) is found this statement based frankly on authority:

> Their longevity is said to be greater than that of man. Mr. Barns thought that his male gorilla had lived a hundred years, but he was frankly voicing a possibility. Mr. Akeley was inclined to think that the age limit was more nearly that of man. This question would be one of the interesting things that could be determined by an experiment station of naturalists in gorilla land.

Actually Barns (1923, p. 132) states:

> As regards longevity, gorillas, on account of their life free from molestation, famine, or disease, and

also judging by the worn teeth of one animal I secured, live, in my opinion, to be a much greater age than man.

Similar statements from earlier but no better informed authorities might be cited in further proof of our assertion that span of life is unknown. Perhaps the tentative statement would be safe that judging from rate of growth and probable age at maturity the animal under favorable conditions might be expected to live approximately as long as does uncivilized man.

CHAPTER THIRTY-SEVEN

AFFECTIVE BEHAVIOR OF GORILLA: TEMPERAMENT AND VARIETIES OF EXPRESSION

DISPOSITION and temperament are at best difficult to describe. The task is unusually embarrassing in case of the gorilla because of the highly diversified and seemingly contradictory nature of reports. As one reads them critically he comes to feel that no direct, unqualified, descriptive characterization is possible, and further, that individuality, sex, age, psychophysical condition, and possibly also race or species, are of the utmost importance and must constantly be taken into account when dispositional traits, their variations and correlates, are under consideration. Because the materials on record are so fragmentary, unrelated, difficult to evaluate, unsatisfactory for isolated presentation, we have decided to follow the unusual procedure of presenting a composite picture, the contributions to which we shall not document in detail. Our facts and insights have been derived from scores of sources, many of which either have been cited in the previous chapters or will be used explicitly in the following pages.

The terms used in this portrait sketch have almost without exception been taken from the literature, but we are wholly responsible for arrangement, contrasts, emphasis, and qualifications. We are well aware that this generalized account of gorilla disposition is not likely to apply perfectly to a particular variety, sex, stage of development, or individual. It is avowedly a composite, and therefore existent only as such.

As between Du Chaillu and Akeley the merits of the case appear to be with the latter, for our generalized gorilla is more often shy and retiring than annoyingly aggressive or inquisitive. Unless fearful of harm or ill-tempered because of age, indisposition, injury, or irritation, it is neither savage nor ferocious. Likewise, it is more often timid and conservative than bold and forward in its activities. Conspicuously discreet and careful of self and companions, except under great provocation, it may not be characterized as courageous or cowardly. Sometimes its conservatism and timidity make it appear cowardly, but when circumstances dictate bold aggression it seems capable of highly courageous action.

There is no adequate evidence of natural hostility toward man. The same individual may be friendly at times and again hostile, or it may be very friendly toward one person and hostile toward another. Mistrust and fear of injury seem to be primary conditions of the hostility which is frequently reported. Slyness and cunning as contrasted with directness and frankness of action appear to be characteristic, and so also are self-control, repression, calm, even in face of disturbing conditions. There is remarkable stolidity, independence, and self-dependence, together with a degree of emotional inexpressiveness unmatched in the primates. If direction of interest and attention may be indicated, the term introverted or self-centered would suggest itself by contrast with extraverted or objectively-minded. Possibly the single term self-sufficient or self-dependent most satisfactorily describes the impression which gorilla makes on man.

It is far from easy to decide whether the animal is naturally cruel or kindly, sympathetic or unfeeling, selfish or altruistic, so great are the variations observed. Reason does not appear for assertion that gorilla is less kindly disposed toward other creatures, less sympathetic and less altruistic, than are other anthropoid apes. Certainly

it is not by nature cruel, vindictive, and conspicuously selfish. Of man and of other unfamiliar creatures and environmental situations it is naturally suspicious and distrustful. In temperament it tends to be sullen and moody rather than gay and cheerful. The term phlegmatic seems highly appropriate, whereas sanguine is as obviously inappropriate. But choice between melancholic and choleric is difficult; perhaps they are equally applicable. Our personal bias, however, is in favor of melancholic.

Dispositional contrast between chimpanzee and gorilla diminishes with age. Almost startlingly different are the characteristics of the young. Whereas the chimpanzee is gay, sparkling, sportive, cheerful and optimistic, although easily saddened, depressed, or discouraged, as is the human child, the gorilla is quiet, serious, phlegmatic, and even when playful seemingly very much self-centered. See, for illustration, Sokolowsky (1908, pp. 46-47).

With many mental reservations we have offered this composite picture of gorilla disposition, for it is our conviction that few observers have been long enough associated with gorilla subjects or have become sufficiently familiar with them to supplement accurate observation with sympathetic insight. Partly because of this conviction we refrain from numerous citations, and as an illustration of what may be gained from sustained endeavor present parts of our description of the affective traits and attitudes of a normal captive. We believe, but cannot at this time prove, that this specimen is typical of immature female *G. beringei*. But however the picture may be modified by future research, it accurately represents the individual "Congo."

Congo's temperament and disposition I found peculiarly interesting and puzzling because so utterly different from those of the chimpanzee and orang-utan. It is not easy to describe them adequately, but in this section I shall do my best to present those observations of emotional response which seemed at once most enlightening and most valuable as suggesting problems or furthering their formulation.

Congo's social relations with the Burbridges and me were entirely agreeable. Even apart from our consideration of her needs she seemed to feel friendly toward us, and when not particularly interested in our behavior at least indifferently tolerated our presence or our demands on her. Always she maintained a dignified mien. At first it struck me as distrust, but I later came to interpret it as independence or aloofness. So far as I could make out she was quite as aloof from other objects, including for example her dog playmates, as from us humans. Often it gave one the feeling that she felt superior and I sometimes found myself attributing to her a "superiority complex."

Her interest in things whose value she knew or suspected was ordinarily strong and she was capable of continued and concentrated attention to any situation which particularly interested her. My various experiments demonstrate these facts. But on the other hand she was capable also of ignoring objects and events which I should ordinarily have expected to command or compel her attention. Thus it happened that she would often give up work on problems which I should have expected to be easily soluble, or would abandon trial of a given method because evidently it seemed to her wasteful of effort. Indeed she was quite as ready to quit work on the basis of inadequate prospect of success as to exert her utmost effort persistently when she was satisfied that the environmental situation could be satisfactorily adjusted to or manipulated.

During my few weeks of association with the little gorilla I remarked steady although slow adaptation to the human portion of her social environment. She became distinctly more tolerant of strangers and increasingly willing to try to hold their attention and interest or divert them by her actions. The chimpanzee is notoriously an actor, but Congo when I first met her was mildly resentful of even the gaze of a stranger, and apparently preferred to be let alone or ignored except by those few of us whose acquaintance she had made and whom she moderately trusted.

As I continuously studied her intellectual and affective life I came more and more to feel that hers is a markedly shut-in or introverted personality. Frequently in my notes I used the words reserved, repressed, inhibited. Whether this characteristic attitude is one of shyness, timidity, or superiority I could never be certain, but gradually I eliminated the former and became increasingly confident that self-dependence and a certain superior aloofness best describe her affective attitude. Many times I attempted to call forth emotional expressions, but seldom did I get marked explicit response. To disagreeable or painful stimuli she reacted by withdrawal or attempted avoidance. Every sort of punishment she received stoically. Even the electrical shock called forth no cry of fright or pain; neither would disappointment in

Fig. 149. The adolescent mountain gorilla Congo. Postures such as this are often taken by gorillas. From Yerkes, Comparative Psychology Monographs.

obtaining food stir her to cries of anger or resentment. Constantly she reminded me of the descriptions of human stoicism. Finally I came to think of her as relatively inexpressive. This of course rendered it extraordinarily difficult to understand her mood or attitude and to get into such intelligently sympathetic relations with her that work or play could go forward with mutual assurance of perfect adaptation. Accustomed as I was to the varied and often violent emotional outbursts of the young chimpanzee I marveled at Congo's calm when her dinner or some other desired object almost within reach was suddenly removed by the experimenter, for her only sign of disappointment or disapproval would be a frowning countenance and perhaps a growl or grunt.

That emotional reactions occurred one cannot doubt; their unusualness is equally certain. Gradually I came to understand that often when I least suspected it Congo was profoundly stirred, but where I looked for visible response of face, bodily attitude, voice, she responded internally or implicitly. A single illustration of this may well be described in detail, for it is typical and was to me extraordinarily illuminating.

Desiring to obtain measurement of Congo's weight I enlisted the aid of a young man in South Jacksonville who was good enough to loan a platform scale. The morning he came to Shady Nook to help me with the weighing it happened that Mr. and Mrs. James Burbridge and also Mr. Ben Burbridge were with me watching Congo's behavior. Having placed the platform scales in a convenient position outside the cage and arranged that my assistant should make the readings, I led Congo forth and tried to induce her to step on the platform. She refused to do this and I found it necessary to put her into position by force. Once placed on the scale she sat there quietly for a sufficient time to enable us to get the weight, but she evidently did not care for the situation. The second time I placed her on the platform she still more obviously resisted and resented my insistence. When I made a third attempt in order to verify our previous weighings she threatened to bite my hand for the first time in all of my contact with her, and then made vigorous effort to escape by running away from me. All of this naturally should have suggested to me that she was profoundly disturbed and was experiencing either fear, anger, or both. But as a fact I was so fully occupied with the task in hand and with securing her coöperation and through it reliable measurements, that I never for a moment suspected the strength of her emotion. I wondered why she should try to bite me or escape, but because of her lack of vocal or other usual anthropoid signs of strong emotion I completely misunderstood or misinterpreted her attitude. Light came to me only after she had been restored to her cage, for her

behavior was then unusual in its indication of relief from strain and reaction. The most marked physiological response, and I think the most significant because seldom observed in Congo although extremely common in the chimpanzee, was temporary diarrhoea. There can be no doubt from this and other unusual signs or symptoms that the weighing procedure had caused Congo extraordinary alarm and had perhaps discomforted her more than anything I had previously done. This was a lesson which I shall never forget. I know now that Congo's emotional life works itself out internally to a far greater extent than externally, and that the term introvert is not inappropriate. (Yerkes, 1927, pp. 169-172.)

Although neither intense of feeling nor emotionally expressive, gorilla is notably subject to moods. The important generalization which we have just formulated, and indeed much of the content of the chapter, we base upon our observation of the immature gorilla Congo and the fragmentary, although often highly significant, contributions made by Savage and Wyman (1847), Du Chaillu (1861, 1867), von Koppenfels (1877), Falkenstein (1879), Hartmann (1885), Garner (1896, 1914), Keith (1899), Grabowsky (1904, 1906), Sokolowsky (1908), Carpenter (1917), Reichenow (1920), Aschemeier (1921), Cunningham (1921), Heck (1922), Barns (1922, 1923), Akeley (1923).

FORMS OF AFFECTIVE BEHAVIOR

THE literature, as well as our own observations, justify the assertion that gorillas are relatively inexpressive of emotions. Forms of behavior which may with assurance be accepted as affective are less numerous and varied than for example in the chimpanzee, and they also are less frequently exhibited. For convenience in systematically presenting the observed facts we shall use in this section the categories of classification which we employed (pp. 285-287) in describing types of affective behavior in the chimpanzee, changing only the order of arrangement. With the exception of sound production and vocalization, which demand more extensive consideration, each of the several categories will be briefly characterized and exemplified in a paragraph.

Bodily attitude, posture, pose. The phenomena thus classifiable appear to be less varied than in the other anthropoid apes and man and less indicative of affectivity. Possibly this is primarily a matter of familiarity and rapport as between gorilla and man, or perhaps instead it indicates partial basis for the character previously referred to as stolidity. The following, from direct observation, is illustrative.

As to bodily attitude. . . . The most commonly expressed affective state was one of contentment or placidity. In this case Congo would stretch herself on the ground on side or belly and lie completely relaxed, sunning herself and perhaps finding amusement in playing in the sand or pulling at the grass about her, or quite as often in playing with her toes. Even a more extreme attitude of relaxation appeared when throwing herself on her back she would place her arms under her head and thus relaxed, enjoy the warm sunshine. These attitudes clearly enough expressed genuine satisfaction. Resentment and incipient anger I have seen in a tense muscular condition. My observation does not enable me to go farther than to say that her bodily condition gave one the feeling of motor preparedness. (Yerkes, 1927, p. 175.)

The emotional tremor commonly observed in various mammals has been reported for the young gorilla in situations which induced fear (Grabowsky, 1904, p. 257) and sex excitement (Yerkes, 1928, p. 69). No studies of the relation of respiration, pulse, temperature, and glandular activity to affective condition have been discovered.

Position, pose, movement (gestures) of head, trunk, limbs, extremities. Again almost complete lack of pertinent information must be reported. We may not infer that there is nothing representative of this category worthy of study, but instead that thus far it has been neglected. Such information as we have at command indicates that gorillas are less given to gesture or expressive poses and movements of head and limbs than are chimpanzees. Handclapping, often referred to in captives, may be imitative of man. Sex appeal by gesture has been described in the adolescent female by Grabowsky (1906, p. 610) and by Yerkes (1928, pp. 67 ff.).

Of gestures there are a few to which emotional significance might be attributed. In general they are suggestive of repulsion or attraction. In this connection I am reminded of Congo's behavior when on her chain as leash I conducted her to and from experiments, or for other reasons shifted her from one part of her limited environment to another. Often, if not usually, when we started out on such a short trip she would desire to go in some other direction than that chosen by me. It was therefore necessary for me to exercise restraining and directing force. Mostly in such cases she would for a few seconds drag on the chain with intent to have her own way. Then as though convinced that mine was the stronger and dominant personality she would suddenly give in and go my way. The really striking thing about this behavior was the suddenness and completeness of the change in attitude. Almost in a flash she became transformed from a strongly resistant animal to one entirely docile and willing to do my bidding. (Yerkes, 1927, pp. 176-177.)

Facial expression. We suspect that observation and interpretation of facial expression are functions of familiarity. This may in part account for the fact that the face of the gorilla seems to most persons much less expressive of emotions than that of chimpanzee or man. Certain play of feature, including grimaces and what are often spoken of as weeping, sobbing, smiling, laughter, and the extreme changes associated with terror and rage, have often been observed, although in no instance adequately described. Again we illustrate from our own observational experience:

Occasionally in the previous sections I have referred in passing to facial appearance. There is no denying that the eyes, mouth, nose, and lips of the young gorilla are potentially expressive. In spite of evidence to the contrary it still seems to me that they should be as expressive as in us. On the one hand, I am certain that Congo's face is capable of varied expression, and on the other I am equally sure that it seldom clearly reflects her attitudes, or perhaps I might more safely say that it usually reflects a calm, placid, self-dependent state. This emotional equilibrium was so stable, so seldom upset in the course of our day's work, so rarely disturbed to any considerable degree even by the extraordinary things I did and demands I made, that I possibly relaxed my vigil for facial changes and therefore missed certain minor modifications which photographic records would have revealed. I found it extremely difficult to read Congo's eyes; her lips were little used, affectively speaking, by comparison with those of the chimpanzee, and her nose changed its configuration only under very exceptional conditions and stress. (Yerkes, 1927, pp. 174-175.)

Appearance, condition, and configuration of skin and hair. The appearance of the skin is known to change with light and temperature, becoming lighter or darker, in accordance with exposure, and more or less moist with activity of the sweat glands (Yerkes, 1927, p. 15). Erection of the hair of the body in emotion-evoking situations we have not observed. It is referred to by Hermes (1892, p. 580). Presumably it occurs somewhat as in the chimpanzee, for it has several times been reported that the hair on the occiput and neck rises under provocation. Possibly this phenomenon is most conspicuous in the male. Von Koppenfels (1877, p. 420) remarks of such an individual when pressed by the hunter: "The shaggy hair upon the head stood up vibrating." We observed in the female Congo erection or bristling of a ruff or collar-like mass of hair at the base of the skull. The mountain gorilla *G. beringei* has a growth of skin, possibly also connective tissue and hair, on the occiput and neck which is referred to by Barns (1923, p. 127) as a "remarkable elongated crown, or rather cranial callosity," and by Burbridge (1928, p. 254) as a "nightcap." As far as discoverable from the literature, this structure is peculiar to the male mountain gorilla. Established also is the fact of movement of the scalp under emotional excitement. Possibly this also is either limited to or more conspicuous in the male of the genus. It is mentioned by Forbes (1894, II, 186) who states: "The Gorilla has the power of moving the scalp freely forward and backward—as Man in many instances has the power of doing—and, when enraged, of corrugating his brows and erecting the hair over the central bony crest. . . ."

Excretory and genital expressions. Under strong emotional excitement, urination and defecation may occur in the gorilla, but such physiological accompaniments of affectivity are less frequently observed and also less pronounced than in the chimpan-

zee. There are indeed few references to the phenomena. Falkenstein (1879, p. 154) mentions that loud, shrill, or startling sounds caused purgation in a young captive male, and Grabowsky (1904, p. 257),

Fig. 150. Congo at attention. From Yerkes, Genetic Psychology Monographs.

whom we quote (p. 467), and Yerkes (1927, p. 172), as previously quoted (p. 458), record temporary diarrhea in conjunction with fear.

Genital changes apparently have not been observed, except by Grabowsky and Yerkes as previously cited.

Social relations. Meager and few are the descriptions of social behavior in relation to affectivity. It is known that social contacts are sought for protection or mutual aid under various circumstances, and in the following sections on evidences of principal types of emotion reference will be made to various social relations observed in affective contacts. Perhaps the paucity of information is correlated with the simplicity of gorilla social life as contrasted with that of chimpanzee and man.

SOUND PRODUCTION, INCLUDING VOCALIZATION

Sound production, including vocalization, is so conspicuously important in gorilla life, and observations relative to it are so abundant, that we are obliged to devote to the subject a section instead of a paragraph.

Of gorilla sounds there are two classes: those produced by the vocal organs and those resulting instead from the beating or pounding of parts of the body or of other objects. Because most authorities have included both types of sound in the same descriptive paragraph, we for simplicity of treatment shall do likewise, but we shall characterize separately sound production in the lowland and in the highland gorillas and shall separate the problem and consideration of language from that of vocalization.

The earliest descriptions, as contrasted with mere mentions, of gorilla vocalizations are those of Du Chaillu. Because of his inimitable exaggeration and the substantial accuracy of his observations, we quote a few extraordinarily valuable paragraphs.

> He was not afraid of us. He stood there, and beat his breast with his huge fists till it resounded like an immense bass-drum, which is their mode of offering defiance; meantime giving vent to roar after roar.
>
> The roar of the gorilla is the most singular and awful noise heard in these African woods. It begins with a sharp *bark,* like an angry dog, then glides into a deep bass *roll,* which literally and closely resembles the roll of distant thunder along the sky, for which I have sometimes been tempted to take it where I did not see the animal. So deep is it that it seems to proceed less from the mouth and throat than from the deep chest and vast paunch. (Du Chaillu, 1861, pp. 70-71.)

According to our authority, the roar of the gorilla may be heard three miles distant and the noise of its chest beating at least a mile away. Finally, he thus inventories vocal expressions:

> The gorilla has no cries or utterances that I have heard except those already described, the short, sharp bark, and the roar of the attacking male, and the scream of the female and young when alarmed; except, indeed, a low kind of cluck, with which the watchful mother seems to call her child to her. The young ones have a cry when in distress; but their voice is harsh, and it is more a moan of pain than a child's cry. (1861, p. 353.)

Repeatedly Du Chaillu refers to the vigorous chest beating of the male when disturbed, attacked, or held at bay. It is drumlike and carries far. Probably because of the incredulity induced by this author's lurid descriptions of the gorilla's ferocity in

defense and attack and his numerous inaccuracies and exaggerations of statement, his account of vocalization was accepted with extreme skepticism and reservations, and his statements about chest beating were generally rejected and by many writers discredited.

The fact, conspicuous though it would seem in the light of our present knowledge, and readily observable, was not definitely established until the appearance of the confirmatory report of von Koppenfels (1877, p. 418), who, of the wild male, reports:

> If he is surprised he stands erect, emits from his deep breast an abrupt, now rumbling, now growling bellow, and beats with his gigantic fists upon his huge breast.

Garner, whose hobby was the study of speech in monkeys and apes, by reason of his unusual experience while living in a cage in the midst of a tropical African jungle, thus adds importantly to the list of sounds previously described:

> I have read and heard descriptions of the sounds made by the gorilla, but nothing ever conveyed to my mind an adequate idea of their true nature, until I heard them myself within a few hundred feet of my cage in the dead of night. By some it has been called roaring, and by others howling; but it is neither truly a roar nor a howl. They utter a peculiar combination of sounds, beginning in a low, smooth tone, which rapidly increases in pitch and frequency, until it becomes a terrific scream. The first part of the series is quite within the scope of the human voice, but as it rises in pitch and increases in volume it passes far beyond the reach of the human lungs. The first sound of the series and each alternate sound is made by expiration, while the intermediate ones appear to be by inspiration, but how it is accomplished is difficult to say. The sound as a whole resembles the braying of an ass, except the notes are shorter, the climax higher, and the sound is louder. A gorilla does not yell in this manner every night, but when he does so it is usually between two and five o'clock in the morning; I have never heard the sound during the day nor in the early part of the night. When he thus screams, he repeats the series from ten to twenty times, at intervals of one or two minutes each. I know of nothing in the way of vocal sounds that can inspire such terror as the voice of the gorilla. It can be heard over a distance of three or four miles. I could assign no definite meaning to it unless it was intended to alarm some intruder that came too near.
>
> One morning between three and four o'clock I heard two of them screaming at the same time. I do not mean to say at the same instant, but at intervals during the same period of time. One of them was within about a third of a mile of me, and the other in another direction perhaps a mile away. The points we occupied respectively formed a scalene triangle. The sounds did not appear to have any reference to each other. Sometimes they would alternate, and at other times they would interrupt each other. They were both made by giants of their kind, and every leaf in the forest vibrated with the sound. This was during the latter part of May. They do scream in this way from time to time throughout the year, but it is most frequent and violent during February and March. (1896, pp. 220-221.)

Garner further reports that the screaming which he heard was accompanied by a peculiar rhythmic beating sound, produced he infers by beating upon a log or piece of dead wood with rapid alternating strokes of the hands.

To us Garner's description of the peculiar gorilla screaming is highly interesting and significant because in the young female mountain gorilla Congo we observed similar reaction, which we characterized as a "shrill tremulous and also tenuous cry similar to the distant neighing of a horse or call of the screech owl." (Yerkes, 1927a, p. 514.) Congo was heard to give this prolonged call only a few times and then as if in response to her dog companions and playmates as they barked and bayed in a neighboring wood. At the time we assumed that the vocalization was a social response, but its similarity to the sound described by Garner and the conditions of observation now suggest to us that it may be a sex call. Supporting this inference is the fact that Garner heard the sound produced alternately early in the morning by two individuals and that this form of vocalization, although occurring throughout the year, is most frequent during the months of February and March. Possibly for the region of observation that is the mating season. In the case of Congo the sexual nature of the sound is suggested by her interest in the dogs and her behavior toward them.

Authorities generally agree that the gorilla is little given to vocalization and it is commonly referred to as silent. In this Garner concurs, for he states:

> One special trait of the gorilla which I wish to emphasise is that he is one of the most taciturn, if not quite the most, of any member of the simian family. This fact does not appear to confirm my theory as to their high type of speech, but it is a fact so far as I observed, although the natives say that they are as loquacious as the chimpanzee. Among the specimens that I have studied, both wild and in captivity, I have never heard but four sounds that differed from each other, and of these only two could properly be defined as speech. I do not include the screaming sound described in another chapter. I have not been able so far to translate the sounds that I have heard, and they cannot be spelled with letters. There is one sound which Othello often used. It was not a speech sound, but a kind of whine, always coupled with a deep sigh. When left alone for a time he became oppressed with solitude. At such times he would heave a deep sigh and utter this strange sound. The tone and manner strongly appealed to the feelings of others, and while he did not appear to address it to any one or have any design in making it, it always touched a sympathetic chord, and I was sometimes tempted to release him. Another sound which was not within the pale of speech was a kind of grumbling sound. This frequently occurred when he was eating. It was not a growl in the proper sense, but was in a way a kind of complaint. Twice I heard this same sound made by wild ones in the forest near my cage. The only thing that I can compare it to in its use is that habit of a cat while eating, to make a peculiar growling sound, which appears to be done only when something else is near. It is possibly intended to deter others from trying to take the food. (1896, pp. 237-238.)

As quoted and cited by Matschie and also by Heck (1922, p. 684), Zenker describes growling, screeching, squeaking sounds as produced by the gorilla, and beating of the cheeks as well as of the chest. Referring to the leader of the band he says:

> If he suspects danger, he drums lightly at first upon his cheeks, opening his mouth and striking with his hand against it. This is a signal, commanding his company to flee. As soon as he sees a larger animal or a man, he beats with his fists in quick alternation against his breast and turns toward the enemy. (Matschie, 1904.)

In Reichenow, whose contributions to many aspects of the mode of life of gorilla are notably important, there is little concerning sound production. Mention is made of a vocal bellow, which seems to be used to warn intruders, and to certain clapping and beating sounds, which however were heard by Reichenow without opportunity for the observation of the mode of production. "Several times I have seen an angry gorilla beat upon the bushes with his arms" (1920, p. 32). It is worthy of remark that neither Garner nor Reichenow observed chest beating in the free wild gorilla.

Thus far the descriptions presented have referred exclusively to the lowland varieties of gorilla. We shall now examine by comparison descriptions of sound production in the highland or mountain varieties. Chief among the contributors to knowledge of this topic are: Lönnberg, Barns, Akeley, and Burbridge.

Arrhenius, in Lönnberg (1917, p. 17), tells of the tremendous noise of barking, screaming, and babbling which results when a band of mountain gorillas is surprised. Screaming roars, whines, and hoarse grunts are mentioned by Barns (1922, p. 83), and the same observer offers a brief but illuminating descriptive paragraph.

> The gorilla, shunning observation at all times, is of a silent, morose, and even phlegmatic disposition. He seldom utters a sound unless thoroughly alarmed, and then his screaming roar is quite terrifying. When interested and curious he utters a loud whine like a great dog, following this by a resonant "clopping" made by beating the closed hand on the bare chest below the nipples. Apart from using this beating of the chest to frighten away an intruder, it seems to be made both as a danger signal and to locate each other's whereabouts, and also, I think, to "hearten" themselves, for I have heard it when there was no possibility of the animals being alarmed. In the course of many weeks spent in observing these apes in the forest, I have never heard them utter a sound at night, and not often in the daytime, by which I judge they are not quarrelsome—the exact opposite to chimpanzis or the baboons. (1923, p. 131.)

Differing from the description commonly given of the roar of the lowland gorilla, Akeley (1923a, p. 432) states that the sound produced by the adult male of *G. be-*

ringei is rather a long-drawn-out, throaty bark than a roar, while Burbridge presents this word picture of gorillas in sound-producing activity:

. . . From the forest below came a curious rattling sound like the chattering of teeth. It persisted for a dozen seconds, ceased, and was repeated. The men looked at each other and muttered "Engabe" (gorilla). Then came a deeper boom, a dull, resounding rapid striking, a muffled drumming which carried with it a certain sense of power. It was like the sound of strong men rapidly beating a carpet. A terrific roar filled the forest stillness. Again and again it crashed, deep and guttural, in answer to the echoes that were flung back and forth among the assembled peaks. In the accompanying silence it came to me that down there beyond the leafy screen an old man gorilla was looking up at us and voicing in his roars and chest beats the ape's ancient defiance of humankind, a defiance as old as Africa. Some observers have likened the roar of a gorilla to a bark. This is true of the animal when pursued, but at bay the vocal utterance is prolonged and tremendous. It rivals even the roar of the lion. The old gorilla below us ceased his roars and chest beats and we followed as the band moved off, crawling through endless tunnels they made through the thickets. (Burbridge, 1928, pp. 217-218.)

Fig. 151. Congo beating her chest. From Yerkes, Genetic Psychology Monographs.

And again:

Though the whole band was concealed from view, they crashed back and forth among the foliage that grew highest just in front of the bending branches of the big tree. The roar of an old man gorilla among them arose above the shrieks of the young and the yells and screams of the females. Now and again he stopped to beat upon his chest with his fists, making a sound like some lunatic pounding a muffled drum. It was just such a demonstration as might be made by a band of enraged monkeys, could it be multiplied many times in sound and fury. (P. 228.)

But by far the most surprising, by reason of the novelty of the phenomenon, is Burbridge's account of a previously unrecorded mode of sound production; namely, teeth-rattling. Various observers have reported chest beating in both lowland and highland gorillas; Zenker has described cheek beating in the lowland gorilla, and Burbridge in the following paragraph indicates the existence of this phenomenon in the mountain variety.

Often had I heard accompanying the muffled drum of a gorilla beating his chest in the forest another, metallic and penetrating, like that a small boy makes when he beats with sticks upon a tin can. Until now I had supposed this sound was produced by a small gorilla beating its chest. Usually there are about sixteen beats, then a pause. A gorilla stands upright, manlike, when producing these sounds. My gorilla in the window suddenly demonstrated. He arose in plain view, mouth open, cheeks drawn taut, and beat a rapid tattoo on each cheek with his open palms. The sound was metallic and far-carrying. Another gorilla, like a jack-in-the-box, popped up into an adjacent opening and drummed on his chin with a rapid circular motion, striking the chin with the backs of his fingers. Often before I had heard this teeth-rattling without seeing the performer. Whether it was a signal or a note of defiance is a matter of conjecture. At least, its effect was electric! (1928, pp. 234-235.)

The evidence justifies assertion that both lowland and highland types of gorilla produce varied sounds by voice and by use of the hands. That the one variety is more given to such reactions than the other is not indicated.

Sound production, because of radical differences in external and internal conditions, might be expected to differ greatly in wild and captive gorillas. What little has been discovered concerning such activities by observation of captive specimens will now be reported. One of the earliest records is that of Falkenstein (1879, p. 152), who, in addition to describing chest beating in his young male captive, especially emphasizes (p. 154) the animal's evident delight in producing sounds by pounding on hollow objects and by striking together or rattling dishes and

tinware. This passion for beating, pounding, or drumming has been discovered also by others and it assuredly is more pronounced in the gorilla than in any other anthropoid ape. The chimpanzee, it is true, claps its hands, beats on the ground or on other objects with its arms and open hands, but so far as we have discovered it has never been observed to beat its chest or any other object with clenched fists.

It is the distinction of Hermes (1892, p. 580) to have reported the only instance known to us of gorilla chest beating with the open hand. Usually observers refer to the hand as closed or clenched, and certainly our own observation supports this statement as opposed to that of Hermes.

The adolescent specimen "Pussi" is said by Grabowsky (1904, p. 256), when in excellent health, to have uttered sounds which may be represented by "u! u! u! u! ūh! ūh! long drawn out, and then at shorter intervals gu! gu! gu! etc." Occasionally this captive, either standing erect or lying on her back, would beat her chest with clenched fist. During periods of sexual excitement she was silent.

For the Dublin captive "Empress," Carpenter (1917, pp. 128 ff.) reports drumming or beating on the chest, handclapping, and a "cry of rage," deep grunts "of satisfaction," and delight in producing noises by rolling an iron dish about the floor. Cunningham observed in the captive "John Daniel" (1921, pp. 118 ff.) hand and chest clapping, childlike crying when reprimanded or disappointed, and shrieking when left alone at night.

Many specimens of lowland gorilla have been observed in captivity and the fact of sound production definitely established. For the mountain gorilla there is by contrast published record of only one individual. The description, therefore, is especially worthy of examination.

The sounds produced vocally or otherwise by the young female Congo are thus inventoried and characterized by Yerkes:

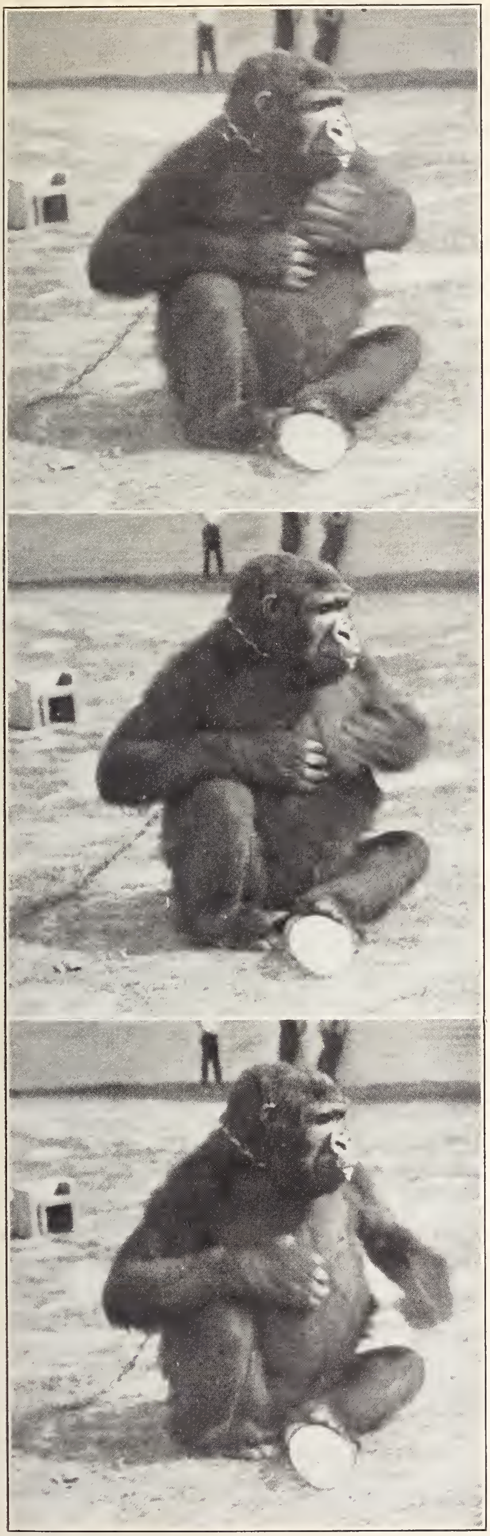
There is first the extremely low, seldom loud, and relatively short, grunt of satisfaction. I several times heard Congo give it when she was especially pleased with her food or with some attention shown her by a friendly human. Occurring under similar circumstances, but perhaps expressive of even keener satisfaction, is a still lower sound which I can describe only by the word purr. When I first heard it I could not believe that it came from the gorilla, it was so low and apparently remote; but on repetition I succeeded in localizing it and in identifying it as most like the purring of a great cat. It is short and seldom produced. A high pitched whine, previously referred to in various connections, is common in conditions which induce lonesomeness or mild discomfort and dissatisfaction. It is perhaps midway between the growl of discontent and the scream of anger or terror. The chief peculiarities of this whine are its high pitch and tremulousness. It is extremely tenuous and therefore utterly incongruous with the build and known strength and vigor of Congo. Contrasted with the short grunt of satisfaction is the growl of resentment or anger. I heard it several times, but never observed its repetition or prolongation. Clearly it is indicative of incipient anger. Occasionally when she was working for food or expecting its appearance from the house Congo would smack her lips, and, as already noted, pages 43 and 46, I convinced myself that this sound has very definite meaning for her and suggests either food or eating.

All of the above vocalizations I heard from time to time, although most of them infrequently, during my days of observation. Quantitative statements are impossible, for I have only impressions to guide me, but as I recollect, the purr I heard not more than three or four times, the grunt of satisfaction perhaps a dozen times, the growl of resentment possibly as frequently as the grunt, the whine of lonesomeness or discontent possibly a score of times. It is safe to add that vocalizations under experimental or natural conditions are rare in Congo the captive; what would be true in nature I cannot say.

Another sound which Congo is said to produce I never heard. It is the somewhat prolonged and vigorous scream indicative of anger and perhaps also of extreme fear. The negro helper described it as occurring when Congo apparently enraged by her bondage attempted to break her chain and escape from the tree to which she had been moored.

Mr. Ben Burbridge has spoken to me frequently of the screams of young gorillas and of the deep growls and roars of adults. I have no other basis, aside from my reading, for description of these vocalizations as I have not had opportunity to hear them.

Of other sounds indicative of emotions there are several. Congo in my presence frequently beat on her chest rhythmically with her two fists, and somewhat less frequently on the ground or con-



venient objects. As a rule not very much noise resulted, but she evidently took considerable satisfaction in the expression itself. I gathered the impression that chest-beating indicates impatience or other mild dissatisfaction, sometimes lonesomeness or slight irritation, and that it may be done to attract attention or to startle or intimidate the observer. (Yerkes, 1927, pp. 172-173.)

During an exciting romp with a human companion and an attempt on his part to lead her, resistant, onto a pier extending over the water, when "almost any other primate with which I am familiar would have vocalized vigorously. . . . Congo, no less stirred in all probability and certainly no less determined to have her own way, nevertheless maintained silence." (Yerkes, 1927a, p. 510.)

The animal's vocal repertoire is reviewed and supplemented as result of additional observations in the following quotation:

In the winter of 1926 she produced only a few varieties of sound, and those infrequently. During the following winter she vocalized only slightly, if at all, more frequently, nor did she exhibit new sounds. The following list of vocal responses is chiefly confirmatory of previous description. It comprehends the chuckle, low throaty growl, and purr-like sounds associated with tickling or occurring in excitement during play; the shrill tremulous and also tenuous cry similar to the distant neighing of a horse or call of the screech owl; the very low throaty purr, sometimes changing into a succession of grunts and suggestive of the cat or the pig, according as the rhythmic purr or the less rapid grunt dominated, and the sharp rhythmic cry made with protruded lips by quick inspiration. Both Mrs. Burbridge and Bill described to me a scream indicative of resentment or disappointment, which appeared in connection with delayed feeding or like disappointing situations. Congo never made this cry in my hearing. As suitable occasions must frequently have appeared, I am forced to infer that in some manner of which I am unconscious, I inhibited this emotional expression. (Yerkes, 1927a, p. 514.)

Chest beating and the pounding of other objects with open hands frequently occurred in Congo. The situations evoking these forms of response varied extremely and our interpretation of the affective significance of the sound production varies correspond-

Fig. 152. Motion picture of the mountain gorilla Congo beating her chest with her hands, while holding a milk bottle with her feet. From Yerkes, Comparative Psychology Monographs.

ingly. At times it seems clearly to indicate vitality, well-being, energy; again, dissatisfaction, irritation, resentment, or anger seem thus to gain expression.

Although language is not necessarily vocal, it is both logical and convenient to examine at this point the evidences of gorilla speech and language. Certain morphologists have indicated that vocal language may not reasonably be expected because the brain shows no development comparable with that usually referred to as "speech center." But however significant this claim or fact may be it would be inexcusable for the psychobiologist to neglect the search for linguistic behavior or the intensive study of such phenomena as may be discovered because the structural neurologist asserts the absence of special organ. Yet in this instance even the most enthusiastic believers in and advocates of speech in infrahuman primates have discovered but scant evidences in the gorilla. Garner (1896, p. 237) mentions only two gorilla sounds which could "properly be defined as speech." Possibly one is justified in describing our knowledge of gorilla language as ignorance and in venturing the surmise that this great ape lacks even a simple primitive system of symbols to which the term language might appropriately be applied.

CHAPTER THIRTY-EIGHT

AFFECTIVE BEHAVIOR IN GORILLA: VARIETIES OF EMOTIONAL PATTERN, AND MOTIVATION

WHEN observational fragments are assembled from diverse sources, analyzed, compared, and classified, it becomes apparent that the emotional life of gorilla is impressively similar to the human in many other respects than variety and complexity. Pertinent information is far from abundant and descriptions without exception are incomplete, but it nevertheless seems desirable to present in the following paragraphs proofs of the existence in the gorilla of several types of emotional pattern which appear also in man and various other primates.

Timidity, fear, terror, shame. Despite such evidences to the contrary as Du Chaillu and many other hunters of gorillas have presented, it may with assurance be stated that the animal naturally is rather shy, and, if not timid, at least eager to avoid attention and the semblance of danger. Like man, it ordinarily is neither rashly aggressive nor foolhardy, but consistently avoids trouble. Although expressions of fear are frequently mentioned, no one has given a detailed description of this behavioral pattern. The best we can do therefore is to establish by authority the existence of emotional attitude. Du Chaillu (1867, p. 69), in an account of the transfer of a young gorilla in a small boat, tells of the animal's extreme terror when a wave broke over it. So likewise Falkenstein (1879, p. 154) reports in a young captive extreme fear of thunder and other loud sounds. Conspicuous fear of the large carnivores is not established by the observations with which we are familiar, but the references are few indeed, and both Cunningham (1921, p. 123) and Yerkes (1928, p. 59) have mentioned fear of strange large animals. "All of our tame apes," writes Pechuël-Loesche (1882, p. 240), "with the exception of the gorilla—which perhaps came out of the wilderness too young and inexperienced—were thrown into great fear when we brought out an old leopard skin stuffed with moss and grass."

Exceptionally important is the description of the adolescent "Pussi's" behavior under naturally disturbing conditions:

> Our female gorilla during the first years of her stay here showed extraordinary fear during a thunder storm or when a shot was fired off in the neighborhood. The animal immediately evacuated and trembled over her whole body. On the 9th of January, 1900, she became so excited over the breaking up of the ice in the Oder in the neighborhood of the Zoölogical Garden, that she evacuated the entire contents of the intestine, ate nothing the whole day and very little the next day. Since then it has been better. (Grabowsky, 1904, p. 257.)

As the gorilla acquires familiarity with his captive environment, and especially with human visitors and caretakers, expressions of timidity and fear tend to vanish, and as it becomes more accustomed to its surroundings it becomes also more contented and healthy. This, a statement of Sokolowsky (1908, p. 22), is confirmed by many observers. Pertinent also is Sokolowsky's report (p. 43) that the young gorilla held captive by Heinicke was sensitive to reprimand and punishment, as are human children. Its feelings apparently could be hurt and it recovered slowly from such affective disturbances. Sensitiveness to command and obedience in a gorilla captive are mentioned also by von Oertzen (1913, p. 12), while Cunningham affirms of "John Daniel" (1921, p. 121) that he seemed to be troubled when persons approached an open window and would draw or push them away. Whether this may be interpreted as fear that they might fall or instead desire on the

part of the gorilla to have the window space to himself is not made clear. Moreover, this specimen would not tolerate punishment or threat of such from a stranger. His owners discovered that the most effective way of disciplining him for misbehavior was to "tell him he was very naughty, and push him away from us; when he would roll on the floor and cry and be very repentant. . . ." (Cunningham, 1921, p. 123.)

Although in general hunters describe either aggressive rage or terror in the adult wild gorilla when at bay, Barns (1923, p. 132) of immature individuals says that they exhibit little sense of danger or fear of the hunter. Certain emotional behavior of the mountain gorilla is thus described by Yerkes (1927a, pp. 510-511):

> During both of my periods of work I was surprised by the infrequent and relatively mild expressions of fear and anger. Not once did I observe anything remotely approaching terror or rage. Timidity and resentment manifested themselves occasionally in connection with the day's work or play; resentment was the more common, and yet even in connection with it I usually felt that she was much more patient and considerate of the desires of the observer than most human subjects of comparable age would have been. All of my efforts to induce anger or rage failed to elicit any pronounced emotional expression. Naturally I supposed that sufficiently disappointing or exasperating situations would induce in so young an animal the temper tantrum or violent expression of displeasure which is natural to child and chimpanzee alike. But such was not the case.

These observations on Congo were later supplemented by experimental test of her response when brought within five yards of cages containing lions, tigers, and leopards. She was obviously enough disturbed by proximity to the animals, but uttered no sound and made no strenuous efforts to escape. Instead she gazed about her and at the animals as if interested, puzzled, and uncertain what to do. The observer was standing a few feet from the gorilla. Suddenly, as if sensing danger, she rushed to him and seizing him with both hands clung as if in terror. Shortly she regained her composure, and stepping away from the observer, again watched the caged animals. A minute or two later, as if startled, she again rushed to the observer. This response was interpreted as an expression of fear and indicative of confidence in her human companion and dependence upon him for protection (Yerkes, 1928, p. 59).

Suspicion, resentment, antagonism, anger, rage, hatred, jealousy. Because fear and anger are closely related and frequently follow one another, it is natural that they should be well-nigh inseparable in descriptions of behavior. Even the very young gorilla, Du Chaillu tells us, may exhibit resentment, hostility, rage, when captured. Of such a specimen we read:

> I never saw so furious a beast in my life as he was. He darted at everyone who came near, bit the bamboos of the house, glared at us with venomous and sullen eyes, and in every motion showed a temper thoroughly wicked and malicious.
>
> As there was no change in this for two days thereafter, but continual moroseness, I tried what starvation would do towards breaking his spirit; also, it began to be troublesome to procure his food from the woods, and I wanted him to become accustomed to civilized food, which was placed before him. But he would touch nothing of the kind; and as for temper, after starving him twenty-four hours, all I gained was that he came slowly up and took some berries from the forest out of my hand, immediately retreating to his corner to eat them. (1861, pp. 209-210.)

And of a baby:

> She was not so ferocious as the male I had before, but quite as treacherous and quite as untameable. She permitted no one to approach her without making offensive demonstrations. (P. 261.)

Even more at variance with the majority of descriptions of the affective behavior of gorillas is Du Chaillu's description of the adult. We present a typical paragraph:

> Then again an advance upon us. Now he was not twelve yards off. I could see plainly the ferocious face of the monstrous ape. It was working with rage; his huge teeth were ground against each other so that we could hear the sound; the skin of the forehead was moved rapidly back and forth, and gave a truly devilish expression to the hideous face: once more he gave out a roar which seemed to shake the woods like thunder, and, looking us in the eyes and beating his breast, advanced again. This time he came within eight yards of us before he stopped. My breath was coming short with ex-

citement as I watched the huge beast. Malaouen said only "Steady!" as he came up. (P. 276.)

Du Chaillu's famous book is filled with such lurid accounts of rage, ferocity, and other intense emotional outbursts.

Behavior suggestive of jealousy we have ourselves observed, but it is rarely mentioned in the literature. Notable is the instance given by Grabowsky (1904, p. 257):

Among the noteworthy peculiarities of our animal should be mentioned her jealousy of her neighbor, a young male chimpanzee, if one paid attention first to him and did not also come to her. She began to growl angrily, to beat on the iron bars of the cage, shove hay out of the netting or throw her drinking dish around, in order to attract attention. If one fed the chimpanzee first, her greed for food was awakened, evidenced by angry groaning. If she herself, however, received something good, she sat down by preference where the chimpanzee could see what she was eating. It even happened that the female gorilla reached over to the chimpanzee food which she herself did not want; especially was this observed repeatedly in the case of the Ficus leaves above mentioned.

Frequently mentioned is resentment of punishment or even the threat of punishment, when the gorilla is not on good terms or is unacquainted with the person threatening it. The fact appears in Cunningham (see our p. 468). That the half-grown male of *G. beringei* may have a temper not unlike that attributed to the genus by Du Chaillu is definitely indicated by Burbridge in his story of the capture of "Bula Matadi."

To capture a twenty-pound gorilla is a good-sized undertaking for a strong man. One weighing one hundred and twenty-six pounds is an impossible antagonist for a man of a hundred and eighty-five. It was at these catch-weights we fought. Had this one been muzzled and handcuffed, perhaps the battle would have been more nearly equal, and he would not have all but captured me. A moment of contact with those powerful arms and I knew I had grabbed a handful. Whether by accident or instinct of gorilla-capturing, I clutched his throat and hung on with desperation born of the knowledge that I was battling for my life. The din of snarls and the thrashing of underbrush as we rolled over and over aroused my men to rush to my assistance. Twice I tore out of the gorilla's teeth and left a part of my clothing as a peace offering. Again and again I broke from clutches that dragged my head and throat downward toward his open jaws. My gun-boy, racing through the jungle ahead of them all, flung himself into the fray. One after another piled on top of the young gorilla, who fought with the fury of a madman as he heaved and bucked under the weight of his enemies, refusing to accept defeat until spread-eagled and his hands and feet tied. While I lay gasping for breath, my men finally got him in a sack, and as this ripped from his attempts to escape, two more were slipped over him and tied. In these he lay packed, breathing heavily through the loose-meshed fiber and looking like a huge sausage. . . .

For the first three days he neither ate nor drank. We gathered for him every forest dainty he was accustomed to, but he met each friendly advance open-mouthed, flinging himself roaring toward any one who approached; but they were always out of reach, and the jerk of the chain as it came taut sent him sprawling backward. Each night by some trickery we got him into his cage and by a cunning device slid the door down behind him. Bula Matadi soon developed an appetite as wild and untrained as his temper. I always fed him myself and spoke gently, playing the kind master, until I saw a danger, the fate that might await any one who fell into his clutches. (1928, pp. 256-257, 260.)

Elation, pleasure, joy, happiness. Reported appearances of joy in living, of the appearance of joking, pranks, tricks, are few and perhaps therefore the more significant.

The following account of moments in family life are quoted from Zenker by Matschie (1904). The description seems generalized rather than circumstantial, and one may therefore suspect its imaginative character. Having described the behavior of a family in search of food, the author continues:

The old master brings up the rear, observing everything, standing erect from time to time and looking in all directions. If he sees nothing suspicious, he sits down on the trunk of a tree and the females bring him fruits, which they lay at his feet. Now and then two of them snuggle up to him and he lays his long arms upon their shoulders and jokes with them, emitting growling, screeching, squeaking noises which sound at times like laughter.

That the well-cared-for Heinicke gorilla was not depressed by captivity but instead enjoyed it is suggested by the following sentences from Sokolowsky (1908, p. 35). Far from quietly brooding,

the young gorilla showed an unmistakable tendency towards humor, since he would gladly make

harmless jokes. On such occasions the open mouth and drawn lips gave the appearance of laughter. At the station he was the favorite of the entire staff. He was not only willingly seen by everyone, but they were fond of playing with him.

The picture is not only that of joy in living, even when a captive, but of certain appreciation of humor and satisfaction in playing practical jokes on his human companions and attendants. This we deem of peculiar significance as suggesting exceptional degree of similarity between gorilla and man.

Similar in its essentials to Sokolowsky's description of joyous emotion in the Heinicke specimen is that of von Oertzen for the little female gorilla called "Hum-Hum." Because paraphrasing is practically impossible we again quote:

Hum-Hum was always kept in freedom. Playing and chasing with the negro friends had no end. Awkwardly the ape whirled around upon herself, clapping her hands lustily, and rolled over on the soft turf, or climbed the Popeia trees. On such occasions the lady showed much humor; if the boys wished to capture the runaway she enjoyed letting one of the heavy fruits plump down upon the head of the pursuer. Then, out of her brown eyes such a roguish joy would shine that one could not long be angry at the joke. Wearied with play, Hum-Hum was loaded like a packet upon the back and so carried away. She made a highly bored face and seemed to take it naturally to lie, careless of her weight, upon the back of a bearer. (Von Oertzen, 1913, p. 12.)

Of one of the specimens which Garner attempted in Africa to accustom to life in captivity in order that she might become a denizen of the New York Zoölogical Park, he writes:

"Dinah" is the only gorilla that I have ever known to attempt a laugh or even a smile; but she does both. When tickled under the arms or on the bottom of the foot, she chuckles audibly, in a manner closely verging on a real laugh, and she seems to enjoy being tickled. She is a real tomboy, and often challenges me for a romp. Frequently when I enter her big cage, she climbs upon my shoulders or head, or slaps my cheeks in a most human-like fashion, beats a tattoo on my back, or snatches off my hat as a mischievous boy would do. She has a real sense of humor, and it often manifests itself in pranks which clearly indicate that she is conscious of being funny. (Garner, 1914, p. 1103.)

"John Daniel" is said by Cunningham (1921, p. 121) to have "giggled and laughed" when being chased playfully by persons, and Yerkes thus describes displays of pleasurable emotion in the gorilla Congo.

Pleasure, delight, or joy in recreation and play I tried to elicit by various games and forms of romping with the little gorilla. Usually, however, I could not be quite certain whether she entirely approved of my playfulness or not. Often she would retreat from me, but it usually seemed rather a ruse to lead me on than a mark of disapproval. When in active, playful, physical contact with me, other persons, or her dog playmates, her face sometimes lighted up and her rather cumbersome body became extremely pliable. Although she evidently had no desire to hurt us but instead sought enjoyment in lively games of running about or chasing, her strength was such that the dogs found her grip anything but comfortable, and even we adults discovered reason to dread her strength of limb and her weight. Extreme anger or terror I never had opportunity to observe. This was a perpetual surprise to me, for I should have considered it impossible to subject a young gorilla to experimental inquiry for a period of weeks without at some time so far running counter to her natural interest and desires as to make her thoroughly angry. I should have expected also very considerable degrees of fear in some of the unusual experimental situations. But here as elsewhere Congo surprised and disappointed me.

It is often said that only man laughs. I am by no means certain that this is true. Indeed I am sure it is not unless one defines laughter subjectively, for the facial expressions of laughter appearing in the gorilla, chimpanzee, and orang-utan are strikingly like those of man. That a sense of humor is involved except in man is doubtful. It was possible to make Congo chuckle or smile with satisfaction, but she seldom responded to any mode of approach with the hilarious chuckles, facial and bodily contortions, and vocalizations of the tickled or amused young chimpanzee. (Yerkes, 1927, pp. 175-176.)

Confidence, sympathy, familiarity, friendliness, affection, love. From observation of the free wild gorilla there is very little evidence of sympathetic emotion, but this may be due rather to difficulties of observation than to the nature of the animal. With captives the situation is different, and there abound proofs of the development of friendly relations, strong attachment, devotion, and perhaps even affection as between young gorillas and persons.

The Bulu natives commonly believe that a wounded gorilla is rescued and carried away by its companions. And Mr. Guthrie presents one "authentic instance" as grounds for such belief. A Bulu once shot a gorilla, and, thinking it dead, cut off a foot to take back to his village. On returning the next morning with companions, the natives discovered that the body was gone, but they followed a trail leading away for fully a mile, where they found the gorilla dead. The trail was stained with blood, and the marks along the trail plainly showed that the gorilla had been carried. (Jenks, 1911, p. 58.)

I was a witness to several instances when gorillas refused to desert their fallen comrades. One morning on the Rembo Elandi, not far from our camp, we encountered a family party of five or more gorillas. Some of them, apparently, had not yet risen from their beds. One old male was on the ground, two were in the trees eating, and the rest were in the nest. One of my native guides advanced as far as was safe, actually to almost under the tree in which the two were feeding, and had the opportunity for close observation of what followed. I shot at one of these gorillas, an animal about two-thirds grown, and saw it tumble from the tree. I ran forward, to find the native standing in surprise at what he had seen. Just as he was beginning his explanation, an old gorilla that had still remained in its bed arose and with a mighty yell retreated into the timber. The guide explained that the gorilla I had shot from the tree fell to the ground, apparently dead, but that another gorilla had rushed up, gathered it in his arms, and carried it into the bush. (Aschemeier, 1921, pp. 90-91.)

By contrast with the above instances of presumably sympathetic emotion Petit (1926, pp. 131-132) reports a hunting experience in which the female of a pair of gorillas having been shot, the male immediately ran away. To us it seems not improbable that this is the typical behavior, for in general the statements of hunters indicate that when a gorilla family or band is surprised it flees in fright and confusion, and that if in the midst of the excitement an individual is shot, its companions are more likely to disappear from the scene than to return immediately at the risk of their own lives to satisfy their curiosity or even give proof of sympathetic emotion. Our surmise is that the emotion of fear or terror is overwhelming and inevitably dominates any possible experience of sympathy.

From the numerous accounts of the behavior of captives we might describe at length manifestations of friendliness with persons and of the development of a degree of sympathetic attachment which made separation disagreeable if not otherwise disadvantageous to the gorilla. Sokolowsky (1908, p. 37) relates the incident of a captive seeking, among the soldiers of the station when at military drill, a favorite companion.

Mongomo, who had struck up a special friendship with one of the soldiers who was with him a great deal, came accidentally to this practice. He saw his friend and to the dismay of the latter who was in the midst of his military detachment, climbed upon his back. The gorilla had sought out purposely, among a large number of like-clad men, one who was especially sympathetic to him.

Confirmed in principle by the experience of various persons who have established friendly relations with healthful, contented, and well-cared-for captive gorillas, and also in numerous instances by our observation of Congo, is the Cunningham account of the sympathetic attitude of John Daniel toward a little girl.

He was especially fond of my little niece, three years old, who used to come with her mother to stay. John and she used to play together for hours and he seemed to understand what she wanted him to do. If she ever cried, and her mother would go and pick her up, John would always try and nip the mother or give her a smack with the full weight of his hands, evidently thinking that she was the cause of the child's tears. (Cunningham, 1921, p. 121.)

Of attachment among members of the species few examples are available because rarely has opportunity offered for study of a group or even a pair of captives. In this respect the experience of the hunter Ben Burbridge is almost unique, for during certain periods he has had as many as four young gorillas in captivity in the Belgian Congo. The following we take from his account of the attempt to transport a gorilla quartet from their native land to Europe. It exhibits some of the difficulties of such an undertaking as well as sympathetic gorilla relations.

In the march back through the interior the shadow of mishap that always seems to follow captured gorillas first descended on Lulanga. She died of influenza, contracted from the natives, and passed as quietly and peaceably as the placid waters of Lake Kivu, beside which she sleeps. Kivu went next with his teeth clenched, unrelenting even in death. And when at last after months of travel the now affectionate little Mikeno held up his hands to me in a last farewell, on the shores of the Indian Ocean, only Quahalie remained. By agreement with the Belgian Government, this, the last of my pets, was to be given to the Antwerp Zoölogical Gardens. . . .

The *Hi-hi-hi* of the rickshaw boys came from the sun-beaten streets of Dar-es-Salaam and augmented a volley of chatters and whistles that surged in from the string of parrot cages hung in front of an Indian shop across the way from my hotel. But Mikeno was dying, dying with the sun. I gave him into the arms of Quahalie, who received him in tenderest maternal solicitude. In the morning I found them wrapped in the same embrace, but Mikeno was dead. I disengaged them gently and put him in a box. Hours later, when men came to remove it, Quahalie gave one long sobbing cry and buried her face in her hands. (Burbridge, 1928, pp. 277-278.)

Depression, grief, sorrow, melancholy, lonesomeness. The passage quoted from Burbridge constitutes natural transition from sympathetic emotion to depression and grief. Sympathetic relationship implies the possibility of lonesomeness and more or less pronounced and acute emotional discomfort. The gorilla is a creature of moods. It more often appears to be melancholy than elated. Numerous are the reports of lonesomeness, depression, melancholy, induced apparently by captivity or by separation from kind or from human friends and companions. Because the statement is typical and also because he has the reputation of being at once a reliable and important contributor to knowledge of the free wild life of the gorilla, we present von Oertzen's brief account of the death of the little captive Hum-Hum:

Hum-Hum had lost all joy in living. She succeeded in living to reach Hamburg, and from there, the Animal Park at Stellingen, with all her caretakers, but her energy did not return again. With signs of the greatest sadness of soul Hum-Hum mourned over the happy past. One could find no fatal illness; it was as always with these costly animals: "She died of a broken heart." With all care, perhaps the transportation by sea had not been managed quite correctly. Perhaps it would have been better for this animal which loves company if it could have played about on the deck instead of being kept in the cabin. (Von Oertzen, 1913, p. 14.)

We are less concerned in establishing, by presentation of evidence, the existence of grief and kindred emotional states in the gorilla than in discovering their biological significance. For if the phrase "she died of a broken heart," used by von Oertzen in quotation marks presumably because at once so common and so incredible, has meaning, the fact may be of profound importance to students of genetic psychology. We turn, therefore, to a brief examination of observations in their possible relations to the life of the animal.

Many authors have intimated, and a few have definitely asserted, that mental attitude as in lonesomeness, discontent, melancholy, grief, may have much to do with the speedy death of captive gorillas. They die, it is said, from grief or lonesomeness induced by separation from familiar persons and familiar haunts. Presumably the intended meaning of this assertion is, as in the case of human death from grief, that the psychobiological condition designated by the affective term is unfavorable to vital processes and becomes the condition of changes in bodily function which eventuate in death.

When, lacking intimate acquaintance with the totality of the behavioral literature on gorilla and also with the animal itself as subject of observation, we began to assemble and evaluate the materials for this volume, we considered such statements as are typified by "she died of a broken heart" instances of gross and uncritical anthropomorphism which should not be taken seriously. But, with increasing knowledge and insight, our opinion has changed radically, for we now are ready to believe, although we make no assertion dogmatically, that the life of gorilla, like that of man, may be unfavorably affected, even to fatality, by mental condition. The evidences indeed are

numerous, cumulative, and to the unbiased scientist we believe also convincing, that often if not generally gorillas taken captive quickly suffer physical deterioration and death from disturbances of the digestive, excretory, and respiratory systems when environmental change induces loss of interest in surroundings, lonesomeness, depression, and melancholy.

We do not imagine, still less do we assert, that the mental conditions are causal. Instead, we surmise that the total psychobiological condition, designated by lonesomeness, or in another instance by grief, is unfavorable to certain vital activities and tends to be followed by, possibly actually to condition as train of events, loss of appetite, indigestion, refusal of food, increasingly serious disturbance of the digestive and excretory processes, and, finally, acute fatal pathological changes due to inanition, toxines, and bacterial invasion. To the natural objection: "How be certain which is cause, which effect, mental depression and loss of appetite?" our reply is: The observed facts in many cases seem clearly to indicate the primacy of mental condition.

Admitting, then, that definite proof is lacking and that even statement of opinion is hazardous because so readily misunderstood, we wish to maintain as our interpretation of the evidences now available that if it is legitimate to speak of man as dying because of grief, shock, disappointment, or any other psychobiological condition, then in the same sense the statement may be applied to the gorilla. This indeed is one of the most interesting, important, and intriguing assemblages of problems suggested by gorilla behavior. Undeniably the animal usually succumbs readily to conditions of captive existence. Undeniable also is the frequency of evidence that the captive early loses interest in its surroundings, becomes apathetic, depressed, melancholy, and speedily loses vitality and resistance to disease. Nevertheless it is entirely possible that a host of observers of these characteristic happenings may have misunderstood and misinterpreted them. We, as it happens, in this instance, agree with the majority and maintain as an entirely logical, plausible proposition the statement that the gorilla is peculiarly susceptible to unfavorable psychobiological states or conditions, and is therefore more difficult than is any other anthropoid ape to maintain in contented and healthy captivity.

MOTIVATION

On the assumption that gorilla behavior is motivated more often by affective than by cognitive factors in experience and bodily process, we include in this chapter an account of conspicuously important features exhibited by experimental study of the mountain gorilla Congo. So far as we know, other evidences of motivating conditions or contributions to analysis of motivation in the gorilla are lacking.

Desire in Congo was complexly conditioned. If food were exhibited to her and held in prospect, her efforts to obtain it were influenced not merely by the visual experience of the desired object, but as well and in varying measure by its nature or quality, its amount, its location and accessibility, and in some instances by her previous experience in obtaining or attempting to obtain food in more or less similar experimental situations. The descriptive story is a long one and we may not hope to deal with it adequately and also briefly. The observer has presented certain combinations of summary and interpretative statement which justify quotation.

In the past twenty-five years I have become familiar in one experimental connection or another with the behavior of a considerable variety of highly organized infrahuman creatures. In no one of them have I noted the definite relationship of reward to attitude and effort which appeared in Congo. Three factors obviously affected the value of the reward: the nature and quality of the food offered, its amount, and its difficultness of access. Many times I have seen Congo glance in the direction of much desired food and refrain even from moving toward or reaching for it because it was just beyond reach, or because she was incapable of using satisfactorily the object provided as instrumental aid. Often, too, she would refuse to work because she did not at that moment care for the

particular sort of food offered. When orange did not provoke effort, apple might; or when that failed, either sweet potato or banana almost certainly would. These observations I can match from my study of the other manlike apes, but the following with much less assurance.

Congo evidently was influenced in marked degree by the quantity of food offered. Whereas half a banana might command scant attention and no effort, a whole banana might stir her to strenuous and prolonged attempts to obtain it. As from day to day I followed her behavior and its development in the experimental situations I became increasingly certain that in the problem of the relationship of attention, effort, and characteristics of response to the nature of the reward, objective, or incentive, we have an assemblage of problems whose solution is important at once for our general understanding of the behavior of animals in experimental situations and for our analysis of those types of adaptive behavior which involve ideation. Is not something akin to ideation necessary for the sort of regulation of action in relation to quality, quantity, and accessibility of reward displayed by Congo? It is unnecessary to defend here the presentation of these observations under "evidences of insight." I am sure of the considerable significance of the facts themselves. The interpretation is of secondary importance or, if you like, negligible. (Yerkes, 1927, pp. 159-160.)

And also the following, because it exhibits moods and other affective conditions in certain of their motivational aspects and relations and carries a step further analysis of gorilla motivation:

In the day's work, as already suggested, appeared different and also varying moods. There were good and bad days primarily because of Congo's condition of depression or exultation, hopefulness or the opposite. Moods were even more in evidence than transient emotions. If I were to attempt a brief characterization of Congo's affective life I should say that it is one of moods rather than of feelings and emotions in the human sense. In the previous report attention was given to evidences of good and bad working days, and their relation to the affective condition of Congo. During my recent period of work evidence of dependence of experimental results upon moods continued to accumulate. Thus, for example, there appeared not only pronounced variations in days but also in experiments. Brought to a given situation, Congo might go to woik eagerly or refuse to attend to it. An illustration may be taken from the box stacking experiment. A large reward had been offered for effort, but Congo, although undoubtedly hungry, behaved as though indifferent to the food. She acted as though she were not interested, but in so doing I suspect that she misrepresented or disguised her true feeling, purpose, and intent. Possibly this is what is meant by "Harvard indifference"!

From records for February 18 the following affective data bearing on motivation are taken. The day was an extraordinarily eventful one. Congo led off with a pronounced and unexpected success in the pipe and rod and box and pole experiment, and not only did she use the same type of tool in different situations, but she also sought, as opportunity offered, to use different objects—sticks, straws, chains, papers, cloths—for the same purpose. Success seemed characteristic of the day. Brought to a new problematic situation, the slot box and stick experiment, she worked with eagerness and definite indications of insight, and although she failed to obtain the reward she exhibited prolonged and diligent effort. Now, it happens that the slot-box experiment in its original form was one in which the gorilla succeeded initially, to her very obvious satisfaction. Thus the slot box itself had acquired certain affective value and Congo came to the new situation optimistically because of her previous easy success. She was misled in that she failed to appreciate that the problem presented by the box had been modified by the narrowing of the slots and that now a stick or other implement must be used instead of her fingers. This behavioral situation is mentioned because of its extraordinarily important bearing on the problem of motivation. The matter deserves further consideration.

Commonly we students of animal behavior assume that some particular factor or condition which we have selected as incentive to effort or achievement is actually the essential factor in motivation. Hunger, for example, escape from close confinement, achievement of opportunity to play, are assumed to be the controlling elements. Yet day after day and in varied types of experiment and under differing conditions in the same experiment, I have observed that my chosen incentive, deriving from food offered as reward, became subordinated to other factors which I had not anticipated and should little have suspected of being capable of swamping hunger. I could indeed exhibit instance after instance of complicated motivation in which the factors are both immediate and remote, deriving often from previous experiences either in the same problematic situation or in other related situations. There were many times in which my chosen incentive obviously determined the direction of Congo's effort, but I suspect that there were quite as many in which it was of coördinate importance with others or even of minor significance. Without careful analysis and attempts properly to control motivation our ostensibly quantitative studies in habit-formation are almost certain to yield misleading results. From my observations with Congo and other anthropoid apes, I suspect

that a large part of the work on habit-formation in the mammalia is incapable of evaluation or interpretation because of inadequate descriptions of motivation. If there were any semblance of quantitative description in my accounts of the adaptive behavior of Congo, I should be extremely doubtful of their value and correspondingly apologetic. But as a fact I have been aware, almost from the first, of the complicated nature of motivation in my subject and have attempted to discover factors and relations. I am now wholly convinced that the intensive study of motivation is an essential preparation for reliable measurement of rapidity, duration, and other aspects of adaptation.

By reflection on motivation in Congo I am reminded of my varying suspicion that, on the one hand, she was naïve, stupid, or on the other, unexpectedly deep, far-sighted, and given to the practice of craft and cunning. The longer I observe her and the more intimate I become with the nature and conditions of her behavior, the more I suspect that her apparent superficiality or stupidity is grossly misleading. It is her nature apparently to act as though somewhat indifferent to situations which would arouse the interest and hopeful expectancy of various other types of primate. Not only is she silent where one might expect vocal expressions of feeling, emotion, or mood; she also is seemingly stupid or inapt in situations which the other anthropoids promptly master. Is it because she cannot adapt to them or instead because she is motivated by a greater number and variety of factors, and especially by more internal or psycho-physiological factors than, for example, the chimpanzee or orang-outan? This question may not be answered other than tentatively from my data. Like the questions concerning the origin and nature of "research" and "gambling"-attitudes toward the seemingly impossible (p. 505) this problem opens to one's imagination vistas of genetic inquiry and description which when once definitely mastered and set forth in proper proportions and relations will surely have extraordinary scientific and practical significance. (Yerkes, 1927a, pp. 511-514.)

CHAPTER THIRTY-NINE

NERVOUS SYSTEM AND RECEPTIVITY OF GORILLA

EVIDENCE is overwhelming that the brain is the organ of mind and of behavioral adaptation with insight and foresight, and that certain of its peripheral structures are organs of sensibility. Therefore it is needless to defend presentation in this volume of such summary account of the nervous system of the gorilla as promises to be helpful to the psychobiologist. That after scarcely more than mentioning sources of neurological description for gibbon, orang-outan, and chimpanzee, we should deal exceptionally with gorilla demands explanation. Our practical judgment in this matter was determined by the reputedly superior resemblance of gorilla to man, voiced for example by Keith and many other morphological authorities: "Of the various existing anthropoids there can be no doubt that the gorilla shows the greatest assemblage of human characters." (Keith, 1912a, p. 737.) We reason that if this be true it is peculiarly important that the neural structures and functions, the behavior and mind of gorilla be studied intensively in comparison with those of man. This great task, including varied assemblages of problem, should prove alluring, sustaining, and endlessly fascinating to scores of investigators. Doubtless also it will so prove if someone with constructive imagination, patience, skill, and interpretative insight leads the way. Our present obligation and privilege is to point the important opportunity for psychobiological discovery through such comparative study of gorilla and man.

Historically interesting is Owen's (1865, pp. 36 ff.) general description and discussion of the significance of the brain characters of gorilla. Among other important points he notes what is designated as "its early arrest of growth" (p. 37). Keith (1923, p. 267), with much more information at hand, was able to state that

> at birth the brain of the baby gorilla is almost as big as that of the human baby; but whereas the period of rapid growth continues in the human brain throughout infancy, the brain of the gorilla proceeds after birth at a slow pace.

The general and comparative description of the primate brain early published by Broca (1869, pp. 374-394) indicates that the gorilla brain was then very imperfectly and incompletely known.

With this brief historical introduction we refer the reader to bibliographic lists which appear in Keith (1896), Sonntag (1924), and Tilney (1928).

"The brain of man forms the climax of an ascending series. Between the stage represented by the brain of the marmoset and that exemplified by the gorilla a series could be chosen which would exemplify every grade of evolution." Thus wrote Keith in 1926 (p. 491). At the time even more extended comparative study of the primate brain than he suggested was well advanced under the direction of Tilney, to whose original contribution we would now turn for the best available general account of the characteristics of the gorilla brain and the only serious attempt to utilize the facts of structural and functional neurology to reveal the significance of the nervous system in the life of the organism.

We shall preface Tilney's special description of the brain of gorilla by brief account of the objective and plan of his extensive work. It was his avowed purpose to discover the phylogeny of the human brain. Therefore in examining his materials he attended especially to those characters which either because of exceptional stability or change promised to have evolutional or other genetic significance.

For this study in phylogeny eleven types of primate were used: lemur, tarsius, marmoset, howling monkey, baboon, macacus,

gibbon, orang-outan, chimpanzee, gorilla, and man. For convenience of comparison Tilney groups these several types in four categories: lower primates, including the first four types; intermediate primates, including baboon, macacus, and gibbon; higher anthropoids, including the three manlike apes; and primitive and modern man.

For each of these types general description of appearance, mode of life, and behavior is followed by description of those structural characteristics of the brain which the author deems phyletically significant. Attention is given chiefly to the surface appearance of cerebral hemispheres, cerebellum, and brain stem, and to the internal features of the latter as revealed by microscopic studies of sections at several "critical levels" and the reconstruction of the gray matter by the method of Bourne.

To facilitate and render more precise comparison of various structures in the brain stem, the following measurements were made. First, "The transverse proportions of a given structure were estimated in relation to the entire cross section by means of a planimeter." From these observations planimetric coefficients were calculated. Second, observation of the relative length of each structure to the entire length of the brain stem was used as basis for calculation of longitudinal coefficients (Tilney, 1928, I, xi).

Basing his classification chiefly on the structure of the brain Tilney ranks the anthropoid apes in order of increasing resemblance to man as orang-outan, chimpanzee, and gorilla (II, 478). From his volumes we have assembled in the following table for convenience of comparison, total brain weight and weight for the three principal divisions of the brain in man, gorilla, chimpanzee, and orang-outan. The figures for body weight we have supplied.

According to the data of this table, in proportion to body weight the brain of chimpanzee is heavier than that of gorilla, but it appears that in the latter the forebrain is slightly heavier and the midbrain considerably lighter than in either chimpanzee or orang-outan.

According to our authority, the brain of gorilla strikingly resembles that of man in the appearance of the cerebral hemispheres.

> Its general outline and fissural patterns are conspicuously humanoid. . . .
>
> More striking are the accessions to convolutional pattern and richness of fissural impression which occur in the frontal lobe. This feature distinguishes the gorilla's brain from the lower and intermediate primates, and gives it, at least to superficial inspection, predominance over the corresponding lobe in the orang and chimpanzee. (Tilney, 1928, II, 645.)

> All things considered, the convolutional and fissural patterns of the human and gorilla brain coincide so closely that were it not for the great disparity in size between the organs of these two species, the hemispheres of the one might be mistaken for those of the other.
>
> With regard to the cerebellum, equally striking advances have occurred. The entire organ has gained particularly in the region of the lateral lobes, where expansion has produced conspicuous alterations in certain features of its configuration. (II, 652.)

> The external appearance of the brain stem in gorilla gives the impression of an increasing definition in the outlines of all important features. (II, 653-654.)

More useful perhaps than such general descriptive comparisons as our space here permits us to reproduce are the planimetric

BRAIN WEIGHTS

Primate type	*Body weight*	*Brain weight*	*Forebrain index*	*Midbrain index*	*Hindbrain index*
Man	150 lbs.	1100-1500 gms.	86-89%	1-1½%	9½-13%
Gorilla	300 lbs.	450 gms.	84%	2%	14%
Chimpanzee	150 lbs.	350 gms.	83%	5%	12%
Orang-outan	160 lbs.	246 gms.	83%	5%	12%

coefficients which appear in the following table from Tilney (II, 1037). Comparison of these coefficients indicates that whereas on the average the gorilla ranks well above chimpanzee and orang-outan, there are notable exceptions to this rule in several measurements.

Of special interest in the present connection is Tilney's critical comparison of structures which have evolutional significance in the brain stems of the anthropoid apes and their relations to behavior. We shall endeavor to summarize his summary.

The pyramidal system, which we are informed represents "a new adventure in motor organization" and "affords a consistent guide in estimating certain behavioral differences among the primates" (II, 699), yields closely similar planimetric values for each of the great apes: chimpanzee .172, gorilla .161, orang-outan .160. The difference in favor of the chimpanzee is in this instance so considerable that Tilney deems it worthy of remark and explanation. He argues in this wise in favor of the superiority of the gorilla. As contrasted with chimpanzee, the gorilla is at a disadvantage because of physical limitations due to greater size and awkwardness. The orang-outan is handicapped by excessive length of arm (II, 702). In view of the author's endeavor to maintain his rank order for the great apes, it is pertinent to remark that the order of diminishing planimetric coefficient for the pyramidal system is also the order of diminishing behavioral adaptivity as indicated by the materials of the present volume.

The olivary nucleus, which is supposed to have to do with regulation of simultaneous movements of eyes, head, and hand, and to facilitate acquired skilled performances, is considerably larger in gorilla, .186, than in chimpanzee, .174, or in orang-outan, .172. This is taken to indicate the superiority of gorilla, but the author conservatively states that whether the animal actually possesses greater manual deftness than other anthropoid apes "must await still further examination bearing upon the comparative behavior of these three primates." (II, 704.) Again it is our obligation to indicate the contra-

PLANIMETRIC COEFFICIENTS OF THE PRIMATE BRAIN, FROM TILNEY

	Man	Gorilla	Chimpanzee	Orang	Gibbon	Baboon	Macacus	Mycetes	Marmoset	Lemur	Tarsius
Pyramid.	.183	.161	.172	.160	.138	.143	.147	.137	.064	.110	.032
Pontile nuclei.	.550	.480	.400	.300	.200	.164	.150	.103	.095	.055	.057
Cerebral peduncle	.321	.187	.223	.110	.110	.190	.169	.144	.079	.086	.017
Inferior olive.	.226	.186	.174	.172	.155	.125	.128	.120	.038	.060	.042
Nucleus dentatus.	.176	.152	.136	.160	.134	.165	.155	.130	.077	.110	.059
Nucleus globosus.	.023	.0095	.018	.015	.020	.023	.014	.032	.050	.032	.037
Red nucleus.	.128	.096	.086	.087	.051	.060	.057	.081	.044	.012	.034
Superior cerebellar peduncle.	.088	.047	.047	.064	.063	.044	.046	.036	.048	.033	.032
Inferior colliculus.	.070	.111	.132	.131	.130	.155	.175	.182	.210	.223	.337
Superior colliculus	.104	.140	.125	.124	.132	.173	.158	.161	.154	.140	.230
Nucleus of Goll. . .	.064	.086	.050	.048	.034	.086	.076	.131	.068	.041	.026
Nucleus of Burdach.	.100	.081	.073	.093	.068	.065	.086	.113	.043	.049	.029
Nucleus of Deiters.	.065	.072	.077	.054	.085	.060	.075	.114	.077	.082	.180
Nucleus of Schwalbe.	.075	.070	.080	.055	.092	.095	.087	.090	.060	.045	.062

dictory nature of behavioral evidence, for as in the case of the pyramidal system, the results of measurements of adaptivity thus far indicate as order of diminishing ability in acquisition of skilled performances and in manual deftness: chimpanzee, gorilla, orang-outan.

The dorsal sensory nuclei are considered in their relation to discriminative sensibility in the extremities. The nucleus of Goll, according to both planimetric and longitudinal coefficients, is much larger in gorilla than in chimpanzee and slightly larger in the latter than in orang-outan.

> This [remarks the author] may in part be due to the slight advantage which the greatest of these primates has in the development of its foot, which is somewhat better adapted to plantigrade locomotion than that of either the chimpanzee or orang-outang. . . . That locomotion upon the ground has some bearing upon the expansion of the sensory areas, more particularly the tendency to assume the upright posture, is a view which gains some substantiation from the known behavioral reactions of the Simiidae. (Tilney, 1928, II, 706.)

The nucleus of Burdach, as contrasted with that of Goll, yields largest planimetric coefficient for orang-outan, .093, while for gorilla it is .081 and for chimpanzee, .073. This suggests that the orang-outan is superior in "higher manual differentiation" to the gorilla and chimpanzee. "The apparent inconsistencies of such a view are evident at once. To maintain that the orang-outang has a more highly differentiated hand than either the gorilla or the chimpanzee seems untenable by the criteria of our present knowledge. Nevertheless, the differences obtained by actual measurements are sufficiently striking to make this supposition a strong probability." (II, 708.) Once more our comment as psychobiologists is that as far as we have been able to discover from the literature and by original observation, the behavior of the great apes contradicts the structural indications.

For the vestibular nuclei, which presumably have to do with the balancing mechanism of the body, two sets of coefficients are presented: the first for Deiters' area, and the second for the vestibular area. For both the order of diminishing value is: chimpanzee, gorilla, orang-outan. Once more the author attempts to explain and to reconcile with behavioral evidences results which we should not have predicted.

> In this development [Deiters' nucleus] the gorilla is not far behind its apparently better balanced confrere; while the orang shows what appears to be a real inferiority in the central control of its balancing mechanism. It seems probable that because of its great length of arm, this latter form has developed less of the tendencies essential to terrestrial locomotion, while both of the other anthropoids have partially adapted themselves to locomotion upon the ground and in some degree to the upright posture. (Tilney, 1928, II, 712.)

We should have expected the development of the neural control mechanism for bodily balance to vary observably in relation to arborealness and terrestrialness, but in fact the order of increasing magnitude of vestibular nuclei—orang-outan, gorilla, chimpanzee—agrees neither with that of increasing arborealness—gorilla, chimpanzee, orang-outan—nor with that of increasing terrestrialness, orang-outan, chimpanzee, gorilla. Certainly we are far from being able to understand relationships of observed neural structure and observed behavior.

The cerebellar nuclei (dentate nucleus and red nucleus) are considered in relation to coördination of movement, and especially of the more complex movements of the upper extremities. The order of decreasing magnitude for the dentate nucleus is: orang-outan, gorilla, chimpanzee. But the author states that "these figures do not give a comprehensive view of the actual differentiation in this part of the central nervous system" (II, 715), and in view of various other considerations infers that

> if the dentate nucleus in man be accepted as the standard toward which the evolutional process has been tending, it seems reasonable to assign to the gorilla a position immediately below the human type and distinctly above the chimpanzee. This fact in conjunction with the high degree of development in the lateral lobes of the cerebellum implies that the gorilla stands first in the group of the great anthropoids in so far as the coordinative control of its muscles is concerned. (Tilney, 1928, II, 716.)

The red nucleus, which we are told possesses functional significance similar to that of the dentate nucleus, supports the author's claim for the relative superiority of gorilla, since the order of diminishing magnitude of planimetric, although not of longitudinal coefficients is: gorilla, orang-outan, chimpanzee (II, 718).

The author says that few elements in the nervous system afford more convincing evidence of the evolutional process than the pontile nuclei, which have to do with control of skilled movements, and especially complex manual performances. This statement is the more interesting to the psychobiologist because the morphological results are difficult to reconcile with the behavioral. In magnitude of planimetric and longitudinal coefficients of pontile nuclei the great apes rank: gorilla, chimpanzee, orang-outan. If we had been asked to rank them on the basis of acquisition and control of complex manual activities we should have suggested as order of diminishing ability: chimpanzee, orang-outan, gorilla, thus placing the gorilla last instead of first. On this point Tilney says:

> That the gorilla, on the basis of measurement, should appear to be most favored in this regard seems to have no convincing demonstration in the comparative behavior of these animals. The chimpanzee is but little less highly specialized in its skilled motor acts than the gorilla, while both of these species excel the orang-outang. Further opportunity for study of the higher anthropoids may justify the impressions conveyed by the comparative measurements of the pontile nuclei and actually accredit the gorilla with superiority in its acquired motor performances. (II, 719.)

Considered in their relation to the functions of sight and hearing are the midbrain colliculi, which we are informed differ only slightly in the higher anthropoids. The inferior colliculus is smallest in gorilla.

> Interpreted in the light of functional significance, this diminution in the auditory colliculus of gorilla suggests that all motor responses to sudden sounds have less of an immediate reflex quality and more of a deliberative element in their execution. (II, 720-721.)

The superior colliculus, associated as it is with visual function, is largest in gorilla. Again the author finds it somewhat difficult to reconcile structural and functional findings.

> The comparison of the superior colliculus in the higher anthropoids does not furnish as convincing evidence of the telencephalization of the visual function as does the inferior colliculus with reference to the sense of hearing. In fact, the orang-outang and chimpanzee show the greatest amount of deflorescence in this portion of the midbrain and indicate thereby a greater degree of delegation of function to the visual cortex in the cerebral hemispheres. This places the gorilla at a distinct disadvantage in the comparative sense. (II, 722.)

There follows reference to mode of life in its possible bearing on the relative size and development of the midbrain colliculi.

Measurement of the oculomotor decussation in relation to binocular vision yields as order of diminishing coefficients: gorilla, chimpanzee, orang-outan (II, 724). The values for gorilla and chimpanzee are nearly the same, whereas that for orang-outan is considerably less. Present knowledge of visual function would indicate either parity of chimpanzee and gorilla or the superiority of the former.

We conclude this summary of one of the most interesting and perplexing chapters in Tilney's important work by quoting his final paragraph:

> Were it possible to give in summary the relative values of the structural features considered in this comparative review, the place of first importance would undoubtedly fall to the pontile nuclei. Their testimony, as presented in the great anthropoids, conclusively demonstrates a progressive development indicative of expansions in neokinetic organization. To the evidence of the pontile nuclei and the pyramidal system should be added that of the inferior olivary nucleus whose increasing volume and progressive gain in definition denote functional increments in essential accessories to neokinetic development. Likewise, the oculomotor decussation, indicating as it does the degree of organization in ocular conjugation and binocular vision, adds its increasing advantages to the sum of those influences which develop in the interests of neokinetic expansion. The indispensable activity of visual control for the acquisition and maintenance of many skilled movements, contributes the benefits of stereoscopic vision to the direction of finer manual manipulations. And finally, the

deflorescence of the mesencephalic colliculi, progressively advancing through the primate order, typifies that unmistakably evolutional process of telencephalization by which functions originally vested in lower segments of the neuraxis gain more expansible representation in those higher levels especially provided by the cortical regions of the cerebral hemispheres. (II, 725.)

Partly because we are not convinced that Tilney has established the neokinetic superiority of gorilla as compared with chimpanzee and orang-outan, but primarily to suggest the great magnitude of the gulf between gorilla and man, we quote as follows from G. Elliot Smith:

In comparison with the Apes, Man has an enormously enhanced faculty of profiting by experience, and of controlling the impulse to respond to every sensory stimulus in his environment by recalling the consequences of such responses on previous occasions. We may correlate these contrasts in behaviour with the striking differences in the cerebral cortex. In the Ape the activity of the greater part of the neopallium is to a large extent controlled by impressions streaming into its various parts from one or other of the sense-organs or other sensitive structures in the body. In the course of evolution of the human brain there is added to this cortex of Man's Simian progenitor a mass of tissue, roughly, about five hundred cubic centimetres, bigger than the whole of the Gorilla's brain; and as the sensory areas of the human brain are practically equal to those of the Gorilla, all this enormous increase goes to swell the dimensions of those parts of the cortex which do not receive sensory impressions directly. These neopallial areas are at least six times as large in the human brain as they are in the Gorilla's. (Smith, 1912, p. 504.)

RECEPTORS OR SENSE ORGANS

General and superficial accounts of the conspicuous receptors of gorilla are available, but we have failed to discover detailed descriptions of their gross anatomy and their histology. Among historical references we should note I. Geoffroy-Saint-Hilaire (1858-61, pp. 29-30), with its brief and slightly valuable account of "conformation of the organs of sense." The contribution offered by Broca (1869, pp. 326-333) contains little on the receptors of gorilla, although it offers an interesting comparative description of the morphology of the sense organs in man and monkey. By Hartmann (1885, p. 208) the subject is discussed: "The organs of the senses in anthropoids do not present any noteworthy points of difference from these organs in man. I have written, but not yet published, a treatise on the eyes of these animals, showing their general agreement with the conditions of the human eye." And Keith (1896, p. 30), whom we heretofore have relied upon for valuable summary of anthropoid literature and serviceable bibliographies, disappointingly remarks of the organs of sense in gorilla: "These are not likely to show any marked differences from those of man; yet it would be well to give them the attention they have not received." While Sonntag (1924, pp. 314 ff.) summarizes what is known of the organs of touch, sight, and hearing in the manlike apes in brief compass and with few and relatively unimportant references.

Our survey of the literature convinces us that neither the structures nor the functions of gorilla receptors have commanded serious attention. Presumably this is due in part to the extreme difficulty of obtaining materials, for the animals are not only relatively rare, but even captive specimens seldom fall into the hands of investigators at such time and under such circumstances as to permit of the adequate preparation of histological materials.

Among the few contributions to knowledge of the neurology of gorilla sense organs we would especially note the following. The ophthalmoscopic appearance of the eye of gorilla as compared with that of other primates is described by Johnson (1897, pp. 183 ff.). As bearing on problems of genetic relation, evolution, and characteristics of gorilla vision, the following paragraph has obvious importance:

We thus find that we must draw a broad distinction between Man and Monkeys as a group and the Lemuroidae. Man and all the Monkeys and Marmosets without exception possess a macula, a circular pupil, and converge when accommodating for near objects. These characteristics are necessary for binocular vision. The Lemuroidae have not got binocular vision and therefore we find all these peculiarities absent. (P. 186.)

The extraordinary resemblance of the go-

rilla eye to that of man is emphasized by Heine (1906, pp. 612 ff.), who infers from structural conditions that this ape possesses highly developed binocular vision.

Concerning the structure of the organs of hearing, touch, and smell, we have discovered no references worthy of mention. Schlaginhaufen (1905) contributes to knowledge of organs of touch an account of the system of ridges on the soles and palms of gorilla and various other primates. The organs of taste are in part described by Ehlers (1881) and more recently by Stahr (1906, pp. 618 ff.). By the latter the tongue of the gorilla is described as carrying taste buds similar to those of orang-outan, chimpanzee, and man, but differing somewhat from each in frequency and pattern of arrangement. Thus in gorilla the anterior papillae are relatively far removed from the central papilla (p. 626). Stahr's observations were made on the tongue of the Breslau specimen "Pussi." The structure of the gorilla nose and olfactory organs is considered by Seydel (1891).

After all is said, we marvel at the paucity of knowledge concerning gorilla neurology, and especially concerning the organs of sense. Is the situation better when one considers behavioral and experiential evidences of the functioning of receptors?

SENSORY PROCESSES

So little is known about the sensibility and the sensory reactions of gorilla that our original intention of devoting a section of this chapter to each of the known sense modes had to be abandoned. Several general statements about the acuity of the so-called special senses appear in the literature, but most of them are vague, inferential, and unimportant. There is not a single scientific report on the sensory life of gorilla. What is definitely and precisely known on the subject can be indicated by a word—nothing. Strongly suggested is the exclamation: Can the psychobiologist who is searching for a field where all knowledge is new, and where historical background can neither aid nor hinder, fail to be attracted!

Because thus the depth and extent of present ignorance of this subject may be most effectively exhibited and our responsibility for the evaluation of contributions minimized, we shall as far as practicable let authorities speak for themselves in this exposition of the sensory life of the gorilla. The chronological ordering of materials commends itself, and so also does classification by observer rather than by mode of sense, for it happens that many authors characterize more than one sense mode in a single sentence.

In this case history is short and its materials meager. We lack even a seemingly complete and approximately adequate list of the modes of sense in gorilla as contrasted with other types of organism. Du Chaillu, upon whom we have previously relied for startling statements on whatever topic of gorilla life was in point, here fails us almost completely, for only incidentally, and as it were casually, does he mention sensibility. A typical instance is: "They are difficult to approach, as their hearing is acute, and they lose no time in making their escape. . . ." (1861, p. 349.) Burton informs us that certain circumstances make the gorilla "exceedingly wary and keen of eye, if not of smell. Even when roosting by night, it is readily frightened by a footstep; and the crash caused by the mighty bound from branch to branch makes the traveler think that a tree has fallen." (1876, I, 248-249.) Amazingly at variance is this with the picture of gorilla physique and mode of life presented by several competent observers, for Burton's words provoke a picture of a great bird, which, condor-like, when disturbed, clumsily flaps from branch to branch!

It will be recalled that Falkenstein (1879, p. 154) noted the lively interest of his captive gorilla in the playful production of sounds by pounding, throwing things about, or rattling them together. Assuredly this behavior has acoustic significance, but it adds little to knowledge of the characteristics of the mode of sense or of its associated

reactions. Typical of the contribution made by Garner are these sentences:

> The gorilla has good ears, good eyes, and is a skillful bushman. One man walking through the jungle will make more noise than half a dozen gorillas. The gorilla can always see and hear a man before he is seen and heard by him. He is shy, and will not attack a man unless he is disturbed by him. (1896, p. 248.)

Scarcely qualifying as scientific description, yet almost the closest approach thereto discovered by us, is the account given by Grabowsky of the sensory processes of the captive "Pussi":

> The various sense organs of our animal are well developed. The following often repeated observation seems to prove extraordinarily keen hearing. Although the animal had her back turned to the glass wall and therefore could not see the approach of her keeper, on hearing his step amongst those of the people who came and went, she would get up and without turning around would go to the door of the cage and await his entrance.
>
> Her sense of vision seems to be equally good, for her behavior made it clear that she recognized her keeper even while he was 80 to 100 meters from the Ape House. Persons unknown to her whom she saw coming from the same direction she did not permit to disturb her repose.
>
> The animal's sense of smell must also be well developed, for she noticed at once any additional material, although not noticeable to the human nose, which was concealed in her food, in the form of powder placed in fruit or dissolved in drinking water. She would approach such food mistrustfully after long smelling, and would refuse it if the flavor was an unfamiliar one, especially if she did not like it. . . .
>
> The sense of touch in our animal is a very fine one; she reacts to the slightest disturbance. If one tickles her, which she only occasionally allows when she is in especially good spirits, she closes her eyes, lies on her back and makes little grunting sounds. (1904, pp. 255-257.)

Certain evidences of keenness of sight, hearing, or possibly smell, for they are not observationally differentiated, are cited by Sokolowsky (1908, pp. 36-37) in captive gorillas. On the authority of Zenker, Sokolowsky (1908, p. 32) thus characterizes the sensory acuity of the gorilla: "He sees very well, hears still better and scents excellently."

Our interest is piqued by the inference of von Oertzen, as expressed below, that forest habitat is less favorable to the development or evolution of the senses than is that of the plain, and we wish he had discussed the matter further with presentation of evidences and arguments. Our author remarks:

> Sight and hearing are well developed in the gorilla, but as a dweller in the forest these senses could not develop to such completeness as in the apes dwelling on the Steppes. Also the sense of smell does not seem to be very great; but in one specimen caught one could see that he first put everything to his nose before eating it. This animal seems to be especially sensitive to good-smelling things, for he has a preference for rose leaves and pomade, which he eats as delicacies when he has a choice. (Von Oertzen, 1913, pp. 7-8.)

The only mention of aspects of development of sensory processes in the individual (ontogeny) is found in Reichenow, who as previously quoted (p. 449), states that a male infant reacted to strange sounds at three and one-half weeks and at eight weeks fixated and followed a moving object visually. In the third month he would reach for the nursing bottle, and when seven months old he could distinguish persons.

We come now to observations on the mountain gorilla as contrasted with lowland forms. They are few, but have the advantage of being in part naturalistic and in part based upon observations incidental to an experimental study of problems of behavioral adaptation. We present first the opinions of the hunter Barns, who says: "Neither their sense of smell, their hearing, nor their sight seems strongly developed" (1923, p. 132). Because this statement is so oddly at variance with those previously cited or quoted for the lowland varieties of gorilla, one wonders whether species or varietal difference in acuity of sense is indicated, or whether instead it is merely a matter of difference among authors in the usage of terms. That the suggestion of relativity is in point may be inferred from the further observations of Barns: "By comparison, gorilla hunting is an easy task to the pursuit of the cunning chimpanzi, for the latter has all those attributes—quick

hearing, good nose, keen sight, and a general monkey alertness—which its clumsy cousin lacks." (1923, p. 147.)

Aside from Barns's statement, there is no suggestion in the literature that the mountain gorilla differs in sense mode or acuity from its lowland kindred. The natural inference is that the contrast pointed in the last quotation as between mountain gorilla and chimpanzee holds also but not markedly for the lowland and mountain gorillas, since the latter tends evidently to be more terrestrial in its habits and is if anything heavier in build, slower in movement, and more clumsy than the West African forms.

The information relative to sensory processes mentioned above as incidental to an experimental inquiry is supplied by Yerkes in his contribution *The Mind of a Gorilla*, pertinent paragraphs of which follow:

> Definite experimental study of Congo's sensory and perceptual equipment was not attempted, but nevertheless a great many of the observations in connection with experimental situations or incidental to them and to my care and handling of Congo, threw valuable light on receptivity and perceptual status. My descriptive statements must be made with extreme reserve, however, for they are generalizations from a short acquaintance with Congo and are rather in the nature of impressions tentatively advanced than of scientifically accurate assertions.
>
> With this sweeping apology I should say that the visual receptivity of Congo seems to be comparable with our own. Lacking measures of acuity I may not venture on further comparison. Her use of vision seems to be highly effective. I have no indications whatever of the nature and development of color vision, but I gained the very definite impression that vision is the dominant sense in Congo's life.
>
> As my work progressed it became clear that the animal's visual configurations are more or less radically different from our own. This appeared, for example, in her manipulation of such objects as the stick and the box. But always in such instances my knowledge remained inadequate because I failed to analyze the factors of motor adjustment or motor coördination. Perhaps Congo's failure to use the stick definitely and appropriately as a tool was due more largely to lack of the necessary visual-motor coördination than to the nature of visual perception. This idea, however, would not seem to apply to the same extent when the animal placed a rectangular box on the corner of one edge in order to achieve the nearest approach to suspended food; or when instead she lifted the box toward the food and holding it in mid-air tried to climb upon it. Such instances of peculiarity of visual configuration might be multiplied indefinitely.
>
> It is the careful, detailed, analytic study of just such performances on the part of our animal subjects that may be expected to qualify us properly as experimenters and enable us increasingly to devise and create experimental situations suitable to their sensory-perceptual equipment, and calculated to exhibit on the one hand the animal's capacity for adaptation and on the other the modifiability or transformability of sensory configurations. It is increasingly clear to the writer, from his study of Congo, that the results of a considerable proportion of the presumably important studies of methods of learning, adaptive capacity, habit-formation, etc., in animals are determined in the main by the intellectual equipment, experience, pre-suppositions, and prejudices, and above all, the types of perceptual configuration of the experimenter. The experiment may be a human masterpiece, but as likely as not it is so contrived as to give the animal meager opportunity to utilize its peculiar adaptive or expressive capacities. We need, in my opinion, general familiarity with our animal subjects and a sympathetic understanding of them, before we even attempt to design crucial experiments to test their abilities.
>
> Of hearing and auditory perception in Congo I can say little. She seemed to be as keenly aware of the sounds in our common environment as was I; at least as alert in detecting novel or unexpected sounds, and in general interested in the world of sounds and continuously ready to utilize them to her advantage. No experiments on acuity or range of hearing or any aspects of auditory perception were made, but I took considerable pains to record the various forms of vocal expression of the young gorilla, and my natural inference from the nature and variety of these sounds is that Congo has a sense of hearing which is comparable in its development with her sense of sight.
>
> The senses of taste and smell were commonly called into service by new or novel objects whose possible food value was to be tested. Visual inspection seldom convinced Congo that an unfamiliar object might not be eaten. If accessible, it was promptly carried to the nose or mouth, usually both. The few tests of olfactory sensitivity which I carried out had slight value. I discovered that Congo quickly noticed unusual odors, but that the familiar odors of foods, as for example a banana, would cause her to ignore any strange odor which was not positively disagreeable. On the other hand she was quick to detect disagreeable, penetrating, or irritating odors and to form associations which enabled her to avoid them. One demonstration of

this was in connection with tear gas which quite evidently irritated her nose even at a distance of several feet. (Yerkes, 1927, pp. 136-138.)

Because no other mode of sense is definitely known in the gorilla, mention has been made of only the five universally known primate senses: sight, hearing, touch, taste, and smell. Probably intensive research would double or treble this number, but in the absence of the knowledge which might thus be obtained there is absolutely no scientifically satisfactory basis for comparison of the sensory life with that of man or of any other mammal. To enumerate problems of sense psychology or physiology which might well be undertaken with gorilla as subject would be discouraging and also futile, since the list would necessarily be all-inclusive. It is especially important that this field of anthropoid research be cultivated, because so many psychobiological phenomena are dependent upon or intimately related to sensory and perceptual processes.

CHAPTER FORTY

OBSERVATIONAL ABILITY AND PERCEPTUAL PROCESSES IN GORILLA

As we have failed to discover other relevant literature the following contribution to knowledge of the characteristics of observational ability in the gorilla is based wholly on our own work. Perceptual processes, it seems, have been as conspicuously neglected by scientific observers as have the senses. What little we have discovered relative to attention, interest, perceptual processes and their configurational products, is in the nature of by-product of our experimental study of modes of behavioral adaptation in the mountain gorilla Congo. We presume to offer this information in its fragmentariness and indefiniteness solely because it is all, and therefore the best, that is available.

Attention in Congo, as in the chimpanzee and orang-utan, is very definitely directed, concentrated, or intense, and can be observed to cover rather systematically the total experimental situation. It often makes the observer feel that the animal is calmly and deliberately, as well as thoroughly, taking in or sizing up the situation, and that in accordance with the result of this sensory examination, action will be directed or inhibited. It is this sort of examination or survey which leads sometimes to deliberate abandonment of the problem, and again to persistent effort. In the midst of such effort, and especially if success seems not to be approaching, Congo occasionally would pause and seemingly meditate or reflect. I have noticed pauses in response to visual and auditory stimuli; but quite as often there seemed to be no external cause apart from the immediate experimental situation, and one can but suspect that neural activity of the utmost significance for adaptive behavior is going on. In previous descriptions of the behavior of the manlike apes these pauses, suggestive of our own interruptions in work for reflection, have been described. They deserve careful attention in our experimental situations, more accurate description than we have at present, and intensive analytical study in order that we may discover the sequence of psycho-biological events. (Yerkes, 1927, pp. 161-162.)

Examples of sustained attention and active inspection of situations are supplied by several of our experiments, of which we cite the following. First, the problematic situation, which as condition of success required the unwinding of a chain which had been placed on a tree trunk. The subject exhibited from the first lively interest and adaptive response to visual perception of the complex and continuously varying relations of the chain to the tree. As the solution of the problem proceeded,

the outstanding features of her performance were pauses and obvious visual inspection of the relation of the chain to the tree, especially when she made a mistake. Usually she saw what should be done, but often her movements tended to get ahead of her visual observation and she was compelled to retrace her steps and by actually pulling on the chain with her hand test its freedom of motion and discover anew the direction which she should take. (1927a, p. 447.)

Again, in experiment which demanded the use of a stick to obtain food from a slotted box, the animal exhibited extraordinary interest, persistence, and concentration of attention. Yet these, under certain unfavorable conditions, suddenly gave place to "discouragement, coupled with pronounced impatience. . . . She gave relatively little attention to the problem and spent much of her time in beating her chest or endeavoring to escape from the situation." (1927a, p. 430.)

In types of situation which demanded the use of boxes, opportunity appeared for observation of various features of perceptual activity. In one problem a box of markedly differing dimensions had to be used in a particular orientation and location. This of course involved behavioral adjustment to perception of the size and shape of the box and of its relationship to a suspended object which could be reached only when the

box was placed in a certain way. Our description relates that:

When brought to the experiment [repetition after interval of a year] she at once ran to the box, carried it almost to center, and tried to set it on end. It tipped over, and as it lay on one side she mounted it and reached for the bag with both hands, but missed it by two or three inches. Without stopping for a second attempt she scrambled to the ground, promptly set the box on end, mounted it with ease, and on the first attempt readily reached and secured her reward. The time required for success was about forty-five seconds.

Congo's eagerness for this experiment when she first saw the situation and was given opportunity to go to work was remarkable. Evidently she knew that she could succeed and was pleased.

. . . .

There can be no doubt about the gorilla's appreciation of the greatest as contrasted with the other dimensions of the box and her ability to utilize visual data in properly relating the box as implement to the food to be reached. Not only did this experiment in repetition yield success, but the performances described above are markedly better than those observed a year earlier. (1927a, pp. 463-464.)

Observational limitations or inadequacies of motor adjustment to visual configurations are apparent in many of our experiments and especially worthy of attention, for some of the shortcomings or failures which appeared were quite as illuminating as the successes. Congo, for instance, after having, with assistance from the experimenter and persistent crude, slowly improving endeavor, learned to use a stick as an implement in certain very simple situations, for a long time failed to dissociate the stick from its immediate and particular configuration. We have thus described her behavior:

Finally, in commenting on Congo's various performances in these five repetitions of the platform and stick experiment, it may be confidently stated that she is *approaching* a behavioral condition in which if a stick or similar functional object is required, she will definitely search for it. Indications of this adaptive attitude or condition are sufficiently numerous to be impressive, although they are by no means so definite as in the chimpanzee. From her behavior in this experiment it may be asserted that although she is on the alert for anything that can be used to reach with, she does not when faced with a familiar need make continuous systematic search of the cage for sticks or other possible implements. Instead, her observational efforts are rather casual and sporadic, and her successes, even if imaginally conditioned, appear to be in considerable measure happy accidents. (1927a, p. 409.)

An interesting stage in the adaptation of behavior to a novel perceptual experience is afforded by an experiment in which the stick to be used as implement was placed on the subject's side of a grill constituted by vertical iron bars. As the object to be obtained by means of the stick was on the opposite side of the grill it was necessary that the animal so orient the stick that it could be pushed through between the rods and thereupon used.

In her first effort she placed it lengthwise against the grill and pressed against it. When she put it down it chanced to rest with one end on the lower end of the grill and projecting through some six inches. A moment later she noticed the end of the stick on the outside of the grill and immediately pushed it all the way through and used it as a tool. That she had something corresponding to the idea of getting the stick to the opposite side of the grill is conceivable, but appearances did not convince me that her actual success was other than a happy accident. She seemed surprised when the stick went through and suddenly became available in its customary relation to the food.

In my notes on this day's work I find the following reflections: I suspect that slight changes in the stick itself, its relative position, etc., may suffice to upset Congo's adaptation. The matter certainly should be thoroughly tested. The more I observe her, the more evidence I see that she is perceptually, and presumably ideationally also, in the status of an infant. Sensory interrelations appear to be meager and manual adjustments and coördinations often are lacking where I should have expected them. Yet the animal must be four to five years old. . . . It does not seem probable that the gorilla develops less rapidly than does man. Thus far she has failed entirely to dissociate the stick as a tool from its immediate setting. It possesses its experiential value solely because of and in connection with the whole of which it is an essential part. Is dissociation possible? And will Congo presently come to use sticks as tools irrespective of their surroundings? (1927, pp. 54-55.)

The answer to the last question is that the gorilla did finally act as though the stick were dissociated from its particular setting. Often, however, the dissociation seemed incomplete, transient, or variable.

Presumably with prolonged practice these inadequacies of adjustment would have disappeared. Our experience clearly indicates, however, that for this particular subject the use of a given object as instrument and its complete dissociation from the particular situation in which it was originally employed are with difficulty attained.

Yet another variety of perceptual limitation is exhibited by an experiment in which the situation was complicated by the combining of two sets of apparatus, either of which when alone Congo could operate successfully. They are designated as the box and pole and the pipe and rod. In the former food could be obtained by using the pole to push it out of a long box, and in the latter by using the rod to push it out of a pipe. The pole could be used only in the box, whereas the rod could be used in either pipe or box. When the experiments were combined Congo failed to discriminate between pole and rod and to associate each with its appropriate food container. The experiment was arranged to test Congo's discriminative ability and to exhibit effects of her previous training in the two differently set, although essentially similar, problems. The initial result of the complication was confusion, and although the subject in the course of fifteen minutes' work obtained the food from both box and pipe, her adaptation was strikingly slow and uncertain, considering the amount of practice in the separate experiments and the degree of proficiency achieved. Our description of the observation concludes with:

> Nevertheless, I believe that the results of this complication experiment are entirely fair to her mentality and indicative of her present ability in meeting problems. That she should have confused pole with rod initially and used them in their inappropriate relations and unusual associations surprised the observer. It is natural to suppose that the rod should be preferred to the pole because smaller and more easily handled; so probably it would have been used immediately in the pipe had it not been hidden from view within the box. (1927a, p. 425.)

Additional evidence of difficulties in adjustment of acts to perceptual data is provided by certain experiments in which the manipulation of simple mechanisms was required. It was only after prolonged effort and the assistance of the experimenter that the gorilla finally learned to remove an open padlock and a spring snap from their hasps. The history of adaptation seemed to indicate perceptual inadequacy. So important in our judgment is the evidence of peculiar limitations of mechanical ability in the gorilla that we extend our exposition by quotation:

> She worked steadily, using the knuckles of both hands to push the lock about on the face of the box. Evidently she noticed the relation of the lock stem to the staple, for her interest and activity obviously increased when the stem was nearly free from the staple. Thus by continuous manipulation of the lock she succeeded in removing it from the staple in forty-nine seconds. . . .
>
> Thus finally, after prolonged opportunity during the winter of 1926 and several trials a year later, Congo learned to manipulate successfully the open lock in a kind of problematic situation which for the chimpanzee is very easy of mastery. But whereas this ape grasps the lock with its hand and removes it directly, deftly, and with apparent appreciation of its relation to the staple, the gorilla succeeded by means of random manipulation which is best described by the word fumbling. In less time than it required for Congo to learn to manipulate the open lock, an average specimen of chimpanzee would, I believe, learn to use a lock and key, so great is the difference between these anthropoids in mechanical aptitude and accompanying versatility and manual dexterity. (1927a, p. 452.)

In general, Congo's attitude toward problematic situations

> varied more markedly with the nature of the problem and its relation to her adaptive ability or expectation of success than with the hour or the length of time she had been working. In a newly presented experiment she usually worked most energetically and determinedly at the beginning of the trial, and if success was not achieved or clearly approached she tended after a few minutes to abandon her attempts, either temporarily and for a rest interval or for the remainder of the fixed period of observation. Not rarely, however, even after some minutes of inattention to her task, she would return to it with energy and evident determination and hopefulness. (1927a, p. 391.)

Typical examples of sudden and extreme change of attitude are the following. In one

of the experiments a food-containing milk bottle could under certain conditions be moved toward the open end of a box. This is what happened when Congo discovered the fact.

Presently she happened to move it toward the open end of the box. Instantly she perceived her advantage, gave a growl of surprised interest, ran to the open end and looked in. Then she ran to slot 2 and reaching in was able to touch the bottle and to push it still farther toward the opening of the box. Once more returning to the opening she reached in and obtained the bottle. . . .

Congo's change of attitude when she discovered that she could push the bottle toward the opening was impressive and significant. The sound which she made was unusual and her eagerness as she ran to the open end of the box, and thence to slot 2 to push the bottle still farther, were clearly enough indicative of her awareness of approaching success. (1927a, p. 427.)

And this behavior was exhibited in the spring-snap experiment, after Congo in many trials had failed entirely to master the mechanism:

Apparently she was quite ready for something to do. I let her see me place a large orange in the box and then proceeded to demonstrate the removal of the snap as usual. When the mechanism was presented to her for work she began instantly and for four minutes labored almost continuously. She poked at the snap, turned, twisted, and pulled it; only once did she go away and then for but a moment. Once I heard the spring bolt of the snap click; a second later again, and in the next two minutes I heard it several times. She was working with extreme concentration, intense interest, and apparently with approaching localization of attack on the spring bolt. As I watched her fumble with the snap I wondered what she would do if the mechanism were two or three times as large, and therefore easier of manipulation with her short, thick fingers. In my notes on these observations I commented: "Why this great accession of interest in an experiment which at various times in the past fortnight she has virtually given up? Is it the cloudy day, with somewhat lower temperature, coupled with higher humidity and possibly a more stimulating atmosphere? Hunger certainly does not account for her unusual interest and activity." Previously she had succeeded, to my great surprise, in the wound chain experiment and had received her entire breakfast as reward. She had then spent an hour in her cage without attention from the experimenter. Possibly this, combined with her unwonted success in the wound chain experiment and the lure of the large orange, conditioned her favorably for the spring snap problem. Still I am puzzled, for I had no reason to expect other than the usual futile fumbling activity; and whereas previously I have felt reasonably certain that success in removing the snap was almost entirely accidental, I am now warned by the clicking of the spring bolt that the mechanism is being attacked in a manner which promises early success. (1927a, p. 455.)

ATTITUDE, INHIBITION, AND FACILITATION

More important by far than the nature of Congo's observational ability or her facility in adjusting manual operations to the spring snap is her affective attitude toward the problematic situation, for it seems that, given hopefulness or expectation of success, observational limitations, clumsiness of movement, failure of insight, may be overcome and success achieved, whereas in the absence of "optimism," failure is inevitable.

We would further indicate the nature and significance of attitude toward experiments by citing our experience in the box-stacking problems. For Congo the task of constructing a pyramid with four boxes was difficult and often discouraging. On one day she might come to the task eagerly and apparently determined to succeed; the next, she might be negativistic. Such an instance we have thus described:

When brought into this situation Congo paid little attention to boxes or food. Deliberately she knocked 15 from 18; then she proceeded to play with 12, throwing it into the air and moving it about rapidly with hands and feet. Apparently she had definitely given up the problem and was not to be tempted to undertake its solution. Again as I watched her, I wondered whether perhaps in the long run it is good judgment to refuse to attempt the seemingly impossible. Here Congo, as in certain other experiments, after sizing up the situation, definitely refused to work.

In the next trial, 4, she was extremely rambunctious, but only slightly interested in the problematic situation. It was her delight apparently to knock the boxes about as though irritated by them and impatient of their presence.

The fifth trial found her in optimistic mood. She had just succeeded easily in the slot box experiment and, it seemed, was greatly encouraged by the experience. (1927a, pp. 473-474.)

Negativeness not infrequently appeared.

A striking example was afforded by the wound-chain experiment, for in this, although Congo would readily solve the problem when it was set under a tree to which she was accustomed to being fastened during her daily outing, she was usually negativistic or at any rate failed of success when another tree was selected as scene of experiment. It was only by reason of an unusual and peculiar combination of motivational factors that she was finally induced to solve the problem in its relatively unfamiliar setting. We quote at length from our account of this experiment to exhibit positive motivational factors and by contrast negative or inhibiting factors, for certainly in this particular experiment adaptive response instead of being impossible by reason of inadequacy of perception or lack of suitable relation of bodily movement to perception, was definitely inhibited.

Finally, on February 19, I decided to concentrate the entire resources of the day on this particular experiment and to offer what would be relatively a magnificent reward for effort. To this end the experimental situation was set as usual; the familiar chain from the home tree was employed at the unfamiliar tree, and the food plate, sixteen feet northward of the tree, contained two large sweet potatoes, two baked bananas, and an orange. Prior to the experiment Congo had taken nothing except a cup of milk for approximately fifteen hours. Several times prior to the trial, which was made at 10:02, she had vocally begged for food while waiting in her cage. When brought to the experiment and attached to the chain she seemed quite ready to work. Within two minutes she began to fool with the chain. Then she moved toward the plate as far as the chain would permit. Returning she walked about the tree in various directions, now gazing toward the house or elsewhere, and again walking about restlessly. It may here be remarked that restlessness is ordinarily a good sign in a problematic situation. It seems to indicate that hope of success has not been abandoned and that things are happening inside.

At precisely 10:08 Congo started about the trunk of the tree counter-clockwise, but she retraced her steps without completing the turn. Fingering the chain as if to satisfy herself that she had started in the right direction, she again moved about the tree, holding the chain in front of her, and this time passing all the way around the trunk in the correct direction. She next descended to the ground and taking the chain in hand proceeded to go around the tree trunk again in the same fashion. Thus she completed the unwinding of the chain and with its full length available, walked deliberately to the plate and emptied it of its contents.

In addition to the unusually large reward offered and the fact that she had not previously had any portion of her breakfast except her cup of milk, an exceptional condition in this trial was an approaching shower. It is entirely possible that dislike of being away from the shelter of her cage during rainfall may have stirred her to attempt the early completion of her task. At any rate the trial demonstrated that under appropriate conditions she could as readily solve the wound chain problem at the unfamiliar tree as at the home tree. Whether the difference in attitude in the two locations is due to motivation or to specific inhibiting factors does not yet appear.

Naturally it appealed to the experimenter as of considerable interest to discover whether the barriers having once been passed, Congo would continue to work smoothly and successfully in the regular wound chain experiment. Therefore on the following day, in trial numbered 14, she again faced the problem which had been so long unsolved, but which in trial 1 and again in trial 13 she had shown herself capable of solving. In this case the setting of the experiment was as usual. Other experiments had preceded this particular one, Congo had had a portion of her breakfast, and on the plate appeared one baked banana and half of a sweet potato. With little hesitation she attacked the problem and in less than twenty seconds she had succeeded in unwinding the chain and in obtaining her reward. It would seem then that resistance to effort had been overcome and that she was as ready to work at the unfamiliar tree as at the familiar one.

. . . .

It appears that the wound chain problem is readily soluble at the familiar mooring tree, whereas it is seldom solved at the adjacent and relatively unfamiliar tree. The experiments demonstrate Congo's ability to unwind the chain at either tree, and indeed during both winters, she was observed to unwind or untangle her mooring chain in diverse situations, as for example, when wound about stakes, boxes, rods, or other paraphernalia of experimentation. The conclusion is that some undiscovered inhibitory influence restrained her when in the regular setting of the wound chain experiment. This occasionally could be overcome by strong motivation. The experiment is described thus at length, although as a matter of fact only summarily since my notes are extensive, because it throws extraordinarily interesting if somewhat puzzling and inadequate light on certain traits or assemblages of traits exhibited by Congo. Undoubtedly persistent inquiry into the conditions of her behavior would be richly repaid. Unfortunately the circumstances of my work were

such that I could not follow the inquiry further. (1927a, pp. 448-451.)

We have thus by citation and quotation of experimental evidences attempted to indicate important features of perceptual processes in the gorilla in order to prepare the way for discussion of modes of behavioral adaptation. We are aware of the inadequacy of what we have presented and indeed of the present status of knowledge concerning all aspects of the sensory and perceptual life of gorilla.

CHAPTER FORTY-ONE

OPINIONS CONCERNING INTELLIGENCE OF GORILLA

INTELLIGENCE of an animal is indicated, it is said, by degree of success in adapting to or modifying environment. With this dictum in mind we purpose in our concluding chapters on the life of the gorilla to attempt so to exhibit characteristics, modes, and degrees of behavioral adaptation that the reader may estimate for himself the ape's intelligence. Facts are desiderata, but, as usual, materials of direct observation are inadequate for our task and constructive exposition consequently difficult. Among the several contributions to this particular aspect of gorilla psychobiology, there is but one experimental study, and that, to our extreme embarrassment as expositors, is our own. Almost without exception other contributions are brief or fragmentary statements about the impressions of hunters, collectors, field naturalists, or trainers, keepers, and casual observers of captive specimens—persons usually untrained in the techniques of psychobiology and lacking also opportunity or desire to observe and describe accurately and to repeat and control their observations. With these several handicaps, the best we can do is to present consensus of opinion among nontechnical observers and to exhibit the characteristics and degree of intelligence displayed by the lone individual which it was our good fortune to observe intensively over a considerable period.

Various mental and behavioral traits of the gorilla have been mentioned and in part described in the foregoing chapters, and especially in connection with our accounts of mode of life, social relations, and affective behavior, but only incidentally has attention turned to what the psychologist is in the habit of designating as cognitive or intellectual traits or activities. It is one thing to enumerate intellectual characteristics and quite another to express degree of intelligence. In this chapter we doubtless shall succeed best with the exhibition of traits, but we may not legitimately avoid attempts to compare the intelligence of gorilla with that of other anthropoid apes. Indeed our discussion may very appropriately be opened with a *résumé* of lay and scientific opinion as gleaned from the literature concerning the relative intelligence, or, as we should prefer to say, psychobiological adaptivity of the gorilla.

In our chapter 27 on the intelligence of the chimpanzee (p. 337) we presented comparative statements to which the reader should refer in this connection, since repetition and especially requotation is undesirable. There is almost complete consistency in reports to the effect that the African natives who are familiar with both types of ape rank the gorilla lower than the chimpanzee in intelligence. Brief statements to this effect the reader will find in Savage and Wyman (1847, p. 425), Gautier-Laboullay (1858-61, p. 90), I. Geoffroy-Saint-Hilaire (1858-61, p. 54), Reade (1864, p. 184), and in Jenks (1911, p. 58), whose statement we herewith reproduce in part: "The native rates the gorilla as superior to most of the other forest animals of Kamerun, though he wins this distinction more because of his prowess as a fighter than because of his exceptional sagacity. However, he has a reputation for his usual ability to avoid traps, and his ability to free himself even from woven nets, when, very infrequently, he is caught in them." This author however concludes with the assertion that the chimpanzee is considered much superior to the gorilla intellectually.

It is apparent from the literature that native opinion is largely responsible for the accounts of gorilla intelligence and compari-

son thereof with that of the chimpanzee which are offered by travelers, hunters, collectors, and also those who as popularizers or writers of natural histories repeat what they hear or find in print. Although throughout our critical examination of materials we have taken seriously the accounts offered by the natives, we are wholly convinced that in many respects they are unreliable and in others misleading. The opinion concerning the relative intelligence of gorilla and chimpanzee we reject because supporting evidence is lacking. The meager accounts which are to be found in the literature intimate that the natives are influenced by the relative ability of gorilla and chimpanzee to avoid or escape the hunter. This, however, may be as well a function of quickness of response, agility, and speed, as of intelligence. The best we can say of native opinion is that it doubtless represents inference from experience and is assertion of what many persons suppose to be fact. It is our surmise that the important psychobiological differences between gorilla and chimpanzee render reliable comparison by unskilled observers impossible.

There are, aside from the definite expressions or echoes of native opinion, certain other assertions and evidences which should be examined. Under the heading "Psychology," Keith (1896, p. 31), in an abstract of anthropoid literature, informs us that "The intellectual and emotional characters of the gorilla have not been studied so much as even the few opportunities have allowed." Thus at the end of the last century an authority gave notice of the paucity of knowledge and by inference of its inadequacy for such comparison of gorilla and chimpanzee as the natives venture to make. Although so far as we recall, Keith has not committed himself to a rating of the intellectual capacity of gorilla, he places it next to man structurally, and presumably on the basis of neurological resemblance would infer its near kinship to man mentally.

"The intellect of the gorilla," Garner tells us (1896, p. 270), "must not be underrated. He studies the motives and intentions of man with a keen perception, and is seldom mistaken in his interpretation of them." Comparison of intellect in gorilla and chimpanzee Garner avoids, although in the paragraph from which we have quoted he states that "savage and resentful instincts" are stronger in the gorilla. Perhaps one might reasonably infer from his very incomplete picture of the mental characteristics of gorilla and chimpanzee that he was more impressed by differences than by evidences of superiority in the one or the other.

From the imperfect descriptions of captive specimens of gorilla one may tentatively prove either superiority or inferiority to the chimpanzee. It somewhat depends on the bias of the observer and his competency, but more evidently on the physical condition, disposition, and previous experience of the animal. In describing what he assumed to be the first living gorilla in France, Milne-Edwards (1884, pp. 959-960) characterizes the subject's intelligence as little developed and in every way inferior to that of the other anthropoid apes, even including the gibbons. Disposition is described as different from that of the chimpanzee and orang-outan. Whereas these are gentle and sociable in captivity, the gorilla is savage, morose, and brutal.

This specimen lived for only a short time in captivity. Because of this fact, and also the discrepancies between Milne-Edwards' psychological description and those offered by equally reliable observers of other specimens, it is legitimate to doubt the normality of this particular subject or to suspect that it may have possessed an unusually ugly disposition or have been the victim of bad treatment during captivity. Whatever the circumstances, it is worthy of emphasis that the statements of Falkenstein, Carpenter, Cunningham, and Yerkes are radically at variance with those of Milne-Edwards and indicate clearly intellectual superiority of gorilla to gibbon and at least equality with orang-outan and chimpanzee. We reserve for later pages more detailed statements of the specific evidences supplied by these several observers.

With a motley array of information gleaned from hunters and collectors, caretakers of captives, from the literature, and from his own experience in handling anthropoid apes, Sokolowsky writes with obvious conservatism about the intellectual superiority of the chimpanzee. Of the gorilla he says (1908, p. 51) that since it is more careful and deliberate and less flighty and instable than the chimpanzee, we might incline to attribute higher order of intelligence to it. Evidently he questions the reliability of native opinion and the widely prevalent conviction, because of statements in the literature, that the chimpanzee is the more intelligent, and declining to make direct comparison emphasizes points of difference and the desirability of careful and unprejudiced study and description of the traits of the animals. To us Sokolowsky's conservatism, reservations, and cautious comparisons seem wise in the combined light of the content of the pertinent literature and the results of our own experience.

Aschemeier also is a dissenter from native opinion, for he writes:

> Contrary to the opinions of many, the gorilla is, in my experience, just as intelligent as the chimpanzee. I found in every case that, in time of danger, the gorilla used his head better than did the chimpanzee. The latter ape seemed frequently to get "rattled," whereas the gorilla, although not necessarily slow, was, at critical times, much more deliberate in his actions. A chimpanzee always makes off at the first sign of danger, but one never knows when the gorilla may attack. (Aschemeier, 1921, p. 90.)

Discounting, it would appear, either the value of his own observations as hunter of the mountain gorilla or his competency to make comparative statements, Barns (1923, p. 133) cites the opinion that of the chimpanzee, orang-outan, and gorilla, the latter is commonly considered the least intelligent, but he adds the reservation: "The study of live gorillas, however, is far from being complete." [!]

Our account of prevalent opinion concerning the relative intelligence of the gorilla may thus be summarized and concluded. Consensus of opinion from observation of free wild animals by African natives and by white hunters and collectors ranks the gorilla as intellectually inferior to the chimpanzee. The evidence supplied by observation of captive specimens, although varying extremely and difficult to interpret, is believed by most authorities to support native opinion. We must therefore assert as matter of fact that by observers of the living animal the gorilla is thought to be intellectually inferior to the chimpanzee, whereas by morphologists it is inferred, especially because of characteristics of the nervous system, to be superior mentally to all other anthropoid apes and to rank among living organisms next to man.

Primarily because of our intimate acquaintance with gorilla as subject of psychobiological experiment, we venture to disagree with prevalent opinion and to express our conviction that present knowledge is entirely inadequate for comparison of the manlike apes with respect to other than specific traits or behavioral expressions. The existing literature definitely establishes the fact of essential difference in many respects between gorilla and chimpanzee. We maintain that reliable, detailed description of intellectual traits is infinitely more important and more to be desired at the present time than are general statements based upon inadequate knowledge and inference, whether pertaining to intellectual or to other aspects of life. The remainder of this part of our volume will be in the main a defense of our position by the summary presentation of our own observations and of the few related facts which we have discovered in the literature on the psychology of the gorilla.

SOME CONDITIONS OF BEHAVIORAL ADAPTATION

The facts which we are about to state are taken from our observation of the gorilla Congo. We present them as illustrative of conditions which may significantly influence the learning process and habituation. Systematic examination of the conditions of

learning is impracticable because of the obvious limitations of our knowledge, but consideration of such facts as we are about to state should help toward the understanding of gorilla mentality and its expressions in action.

There are three principal assemblages of psychobiological phenomena to be considered. They may be designated, at least tentatively, by the terms destructiveness, inquisitiveness, and imitativeness. Such phenomena as exhibited by Congo we shall now describe by quotation from our reports and by summarizing paraphrase.

We are accustomed to think of the primates, especially in early life, as peculiarly and wantonly destructive. Is this impression in accord with the facts? In experimental as well as other types of situation I have worked over considerable periods with six widely differing primates: marmoset, cebus monkey, orang-utan, chimpanzee, gorilla, and man, and I have observed that they exhibit extreme differences in degree of natural destructiveness. Perhaps in proportion to its strength the monkey deserves first place, but certainly the chimpanzee and the human infant and child compete closely, if not for first then certainly for second place. It has seemed in my experience that destructiveness ordinarily is more or less incidental to the sensory examination and the sensory-perceptual testing or manipulation of objects which in the long run acquaint the organism with the qualities of its environment and give it measured control thereof.

Between a typical chimpanzee of the same age and the gorilla Congo there is an amazing difference in natural destructiveness. Whereas the chimpanzee pounces eagerly upon new things, examines them with every available sense, tests them, manipulates them, and usually in short order demolishes them if this can be done, Congo mostly confined herself to a rather demure and ladylike examination of unfamiliar objects. The scrutiny is primarily visual, tactual, olfactory, and gustatory. If this examination indicates edibility, the appropriate reaction immediately ensues; otherwise the object, unless capable of some peculiar sort of manipulation, tends to be neglected. Never did I see Congo wantonly destroy an object. Yet in her cage at various times, and partly for the express purpose of testing destructiveness, I placed wooden and paper boxes, carpenter's tools, pieces of experimental apparatus, and even a corncob pipe. So much did her lack of destructiveness impress me that I one day recorded in my notes my willingness to trust my best hat in her cage. I should feel fairly confident that if it were left there overnight I should be able to reclaim it the next day, somewhat crumpled and soiled but still a hat. With a monkey or chimpanzee at hand I should feel equally certain that the hat would not be identifiable as such a few hours after its commitment to the cage.

I am coming to suspect that destructiveness is importantly related on the one hand to curiosity and perhaps on the other to mode of learning and to the functioning of different learning processes in specific situations. It therefore is particularly in point to consider Congo's display of curiosity. (Yerkes, 1927, pp. 138-139.)

A year later the behavior of Congo was radically different, as the observer has thus indicated.

During my first period of observation Congo was only slightly destructive. Unfamiliar objects falling into her hands were hastily examined with fingers, nose, and mouth, but proving inedible they rarely were damaged and ordinarily they were thrown aside and utterly ignored after initial inspection. A year later I was much surprised to find destructiveness as pronounced in her as in the chimpanzee of like age. She was more interested in unfamiliar things, and instead of contenting herself with discovering whether or not they were edible, she proceeded in either case to try to dismember them. In 1926, experimental work with her was relatively simple and easy because she seldom tried to destroy the apparatus; but in 1927 nothing was safe from her aggression, and having been seized, from her strength of jaws and limbs. Whether this is a normal, predictable change in behavior, accompanying physical growth and psychophysical development, is not indicated by the literature or by my observations. It is conceivable that increased familiarity with her new environment and general adaptation to conditions of life in captivity released her from certain inhibitions, and that whereas during the first winter she was reluctant to take liberties with the objects about her, she subsequently came to act more freely, spontaneously, and naturally. My suspicion, however, is that the change is due rather to normal psychophysical development than to adaptation. (1927a, pp. 501-502.)

Inquisitiveness, so markedly exhibited by most primates and noted in the gorilla by many hunters, was conspicuous by reason of its near absence in Congo during our first period of observation. Again we quote:

From my first meeting with Congo I was impressed by the relative infrequency of indications of curiosity about unusual objects or events. I continue uncertain whether the animal represses or inhibits the usual primate expressions of curiosity

or instead lacks the experience. In addition to the observations which I made in the course of our daily contacts, I planned many simple experimental situations with intent to elicit gorilla curiosity. The evidences are so abundant that I must limit description to typical examples, whereas I base my impressions and generalizations upon the totality of my observations. (1927, p. 139.)

The experiments referred to included the presentation of various unfamiliar objects which it was thought the gorilla might examine, play with, dismember, or possibly completely destroy. Often she instead completely ignored the object, or having looked at it and smelled it, pushed it aside as though somewhat irritated by its presence. Many examples of such behavior might be cited.

It has been said that between the first and the second period of observation Congo's destructiveness markedly increased. There was similar, although less obvious, increase in inquisitiveness, as stated below:

Curiosity similarly was strangely lacking or disguised in 1926, while in 1927 it was considerably more obvious and played a rather important rôle in the animal's adaptation to new situations. It remained, nevertheless, far below the normal level for the chimpanzee, and whereas Congo, when in the presence of an unusual object or as observer of strange happenings, might inspect, examine, test, or observe in a few ways, the chimpanzee would do so far more persistently and with greater versatility of response. Here, as also in the case of general adaptation, Congo's repertoire of response seemed meager in comparison with our own and also with that of the chimpanzee. Often where one would expect the keenest curiosity she appeared indifferent. But once more emphasis must be laid on temperamental characteristics, for in the second winter she was as introverted, aloof, independent, inclined to indirection, given to simple forms of craft, cunning, and attempts to mislead the observer, as during the initial period of study. Possibly these characteristics and the response pictures which they suggest are incompatible with lively expressions of curiosity. It may even be suspected that were she entirely free from the suspicion of being observed, she might act differently and supply much more varied evidences of curiosity. (1927a, p. 502.)

Curiosity, as behaviorally expressed, leads to survey, examination, exploration, resultant discovery of the qualities or values of objects, and preparation for serviceable adaptations. In such behavior of the ape may be recognized the beginnings of "research." The curiosity-provoking and seemingly purposeless fooling with objects, which is so conspicuous in the monkeys, tends in the anthropoid apes, and especially it would seem in the gorilla as we have attempted to indicate in the following paragraphs, to be supplanted by a more serious type of examination, but the infrequency of such behavior is at once surprising and highly significant in connection with adaptivity. From consideration of affective attitude we make transition in the following quotation to activities which might be expected to eventuate in imitation.

The highly self-dependent attitude of Congo and her aloofness from human beings, except as she feels dependent upon them for her material needs, suggest the term introvert. Are we perhaps dealing in this case with a type of organism which when separated from its kind and compelled to associate with man becomes extremely introverted? And is this condition so far due to the unusual circumstances of life in captivity and of relative isolation from its species that we gain a very misleading notion of the mental traits of the gorilla? Or are shut-in-ness, negativism toward man, and a seeming haughty aloofness characteristic of this king among apes? I have recourse to questions because statements would be even more liable to misconstruction. Congo's behavior has deeply stirred my curiosity, and I have many times asked as I observed her and as I have worked over my notes and manuscript: What are the social and other biological advantages and disadvantages of extraversion and introversion, and why has the gorilla, even as compared with the chimpanzee and orang-utan, lost in the struggle for existence? It is this question which leads me to consider in the following paragraphs, modes of adaptation of behavior as they appear in what I wish to designate as fooling, aping, and imitating.

. . . .

She fools surprisingly little with the objects in her new world. I have almost no convincing evidence of her tendency to ape. It is difficult to believe that she would not ape others of her kind, but I can truthfully say that I never saw her ape me or any other person. True, this may be a case of contrariness or of complete suppression of an ordinarily natural mode of expression. When it comes to imitating with reference rather to purpose than the precise means, the facts are in no

wise different, for Congo simply does not imitate persons with such frequency, freedom, and explicitness that one can feel sure of it. Again I hesitate to believe that she is utterly non-imitative. It seems far more probable that she is non-imitative of us while perhaps somewhat imitative of others of her kind.

What bearing, we may now ask, has Congo's apparent negativism and peculiarity of responsiveness, as compared with the other great apes, on her ability to adapt herself to such problems as I busied myself in presenting to her? Offhand it would seem that she is at a very considerable disadvantage in learning new things because of her lack of abundant and impulsive activity, tendency to test and try everything that comes within reach, and to do what other persons or other animals do, or at least to imitate their actions to the extent of attaining the ends or goals which she sees them attain. If Congo is relatively impulsive, destructive, curious, imitative, she has deceived or misled me amazingly. Her behavior has filled my mind with the impression that she is too much aloof from her environment, too little adventurous, or, in the scientific sense, inquiring, to discover readily and quickly solutions of novel problems and adapt herself to extraordinary environmental demands. If this be true, one can understand why the gorilla should be a disappearing race, and perhaps also why so little relatively is known about its mental traits, and so little sympathy exists between man and gorilla.

Fooling and aping, as do the infrahuman primates and we in our infancy, are conducive to serviceable adaptation through the popularized process of "trial and error." But it would appear that learning on the basis of insight, understanding, or appreciation of relationships between environmental ends and means, or among means themselves, is relatively at least independent of fooling and aping, while conversely largely dependent on that crude form of the spirit of inquiry which we commonly call curiosity and on the tendency to attend to situations as wholes, to survey them completely and in a seemingly appraising way, and then to try out thoroughly and with patient persistence one after another the methods which are made available by the combined native and acquired reactive capacities of the individual. Just because the chimpanzee is much fuller of curiosity and more imitative than the gorilla, it has I suspect outstripped its gigantic fellow-ape in the race for anthropoid supremacy. (1927, pp. 151-154.)

An animal which is imitative of its fellows has very considerable initial advantage in behavioral adaptation. Congo, as we shall now indicate by quotation, profited relatively little and slowly by human tuition. Often she was negativistic instead of eager to utilize social relations to her own advantage.

To pass, then, to the subject of imitativeness, we first of all recognize the fact that there was no opportunity for Congo during my period of observation to imitate other members of her species. The only social factors in her environment were her dog playmates and the persons who visited her, took care of her, or studied her. Almost from the first I gave special attention to imitativeness of persons because I was struck and surprised by Congo's apparently negativistic attitude. In many of the experiments opportunity offered to record imitative responses or the absence of them, and in several it was possible to get something in the nature of measurements of imitative tendency.

Although in the use of the stick Congo eventually learned something by watching me, I am inclined to think it was far less than my notebook descriptions appear to indicate, for what she actually followed observationally was the food and the relation of the stick to it. When the stick happened to come in contact with the food she was alert and eagerly reacted to it as though it were actually a part of the food. Nothing I ever did by way of manipulating objects, whether sticks, boxes, hammer and nails, pencil and paper, pipe, or the parts of my own body, as for example by opening my mouth, grimacing, making gestures, etc., had obvious effect on the form of her response. Sometimes she appeared to be watching intently and with interest; but always her subsequent behavior gave me the feeling that she intended and perhaps preferred to do something different from what I did. This is what I have called negativism. I do not think I am exaggerating Congo's lack of imitativeness of me when I use this term; yet I fully realize that I am going a long way beyond the simple statement that she did not tend to reproduce my acts or to be pronouncedly influenced by them in her solution of problems.

In the several stick, box, and lock problems which I attempted to help Congo with, she gained more I think by watching the result of my series of acts than by following the acts themselves and attempting to reproduce them. In the aggregate I devoted hours to the task of copy-setting, and the acts which I performed with particular intent to assist Congo in learning how to solve various problems ranged all the way from such extremely simple things as merely opening my mouth to show my teeth, to the use of a long stick to push food out of a metal pipe. Usually the copy-setting had some practical objective. Thus I did my best to get Congo to open her mouth so that I might obtain her dental formula and observe the condition of her teeth, but neither imitatively nor otherwise, except by force, could she be induced to spread her jaws widely. Or, again, day after day she saw me

working in and about her cage with a pipe in my mouth; yet when this object was handed to her or placed where she could examine it at her leisure, instead of imitating my use of the object she bit at the corncob bowl as though it were a nut. Never did she give any indication of being influenced by my use of the pipe. How I literally wore myself out trying to get her to imitate me in removing the padlock from its hasp in experiment no. 11 already has been told.

Recalling the natural love of the captive chimpanzee to use for its own amusement, and apparently imitatively, such things as tooth brushes, hair brushes, scrubbing brushes, brooms, wash cloths, I gave Congo similar opportunity, especially with broom and brush; but her interest and response were limited to fingering the objects for a few seconds, smelling or biting at them and pushing them out of the way as though they were not useful parts of her world.

Were it not for my experience in trying to teach Congo to eat unaccustomed foods I should have to say that she almost entirely lacked tendency to imitate me, and that I saw no convincing evidence of imitation of other persons or other animals. But the story of her response to edible things is as different from the above as well could be. When I arrived on the scene, I learned that Congo's diet was very limited, primarily because of her refusal to eat most of the things that were offered her. She was diligently specializing on baked banana, baked sweet potato, orange and apple, and skimmed milk heavily watered. Lettuce, celery, carrots, eggs, bread, meats and various other things which had been offered she had regularly cast aside either with a casual taste or merely a sniff. Knowing that her health and growth might at any time demand a more varied diet I promptly decided to try to teach her to eat other things. This offered an excellent opportunity for copy-setting and I fully availed myself of it. (1927, pp. 142-144.)

The second period of observation in the main confirmed what has been said about imitativeness; but since it also in important respects supplemented information and insights, we once more quote from the report:

The following winter she clearly was more interested in what I did and more inclined to obtain the objective toward which my actions tended, even though she failed to observe or was unable or unwilling to imitate my actions. Almost never did I notice evidence that my setting of copy for her in experiments which she had failed to solve did more than encourage her to renewed or more vigorous efforts of her own particular kind. Even my tuitional attempts slightly, if at all, modified her modes of response. Often they stirred her to redoubled effort to secure the prospective reward, and occasionally they seemed somewhat to modify her method of attack on the problem. This is strikingly different from common experience with the chimpanzee, which readily and eagerly imitates man as well as members of its species. It seemingly watches for opportunity to imitate, with respect alike to mode of response and objective attained (means and end), whereas Congo seemed oblivious of the features of imitative copy and intent only on the objective which both imitator and imitatee had in view.

. . . .

In the previous report, a section was devoted to the discussion of fooling, aping, and imitating. Therein it was asserted that Congo exhibits in far less degree than do the other great apes random investigative activity, copying or seemingly purposeless and almost automatic repetition of the acts of others, and intelligent imitation. At once less of an investigator and less imitative than the chimpanzee, she is also, it would appear from my varied observations, less willing or eager to work persistently in the face of discouraging conditions. Eager and optimistic in the first stages of work on a problem, she tends after a time to abandon it as insoluble, unless in the meantime she achieves an encouraging measure of success. Otherwise expressed, the gorilla, like not a few men, roughly measures or estimates the probability of success, and if the chances seem to be against her, gives up the task. What at the start appears to her impossible she will not even attempt.

Herein appears what may be one of the most important differences between this anthropoid and mankind, for whereas Congo either refused to work, or shortly abandoned effort, in problematic situations which must have seemed to her impossible of solution, some men commonly stigmatized as foolish, eagerly and insistently strive for what is unpredictable. This may be not only the most important difference between man and other organisms, but also the secret of human progress and the key to the development of human types of civilization and culture. Certainly if no representatives of our genus were willing to attempt the impossible, and even to devote their lives to a goal which may be many generations distant, progress would be relatively slow. The chimpanzee is more nearly an investigator, although of primitive type, than any other of the great apes, and therein it is comparable with man. That it likewise most closely resembles man in its attitude toward the seemingly unattainable goal is not yet evident. In future observation of the anthropoids and other primates it will be of very considerable interest and significance to trace origins, developments, and relationships of the attitudes, reactive tendencies, and modes of adaptation which are comprehended in the concepts research and gambling. For although some may object to the latter term to designate willingness to strive for the unpredictable,

it nevertheless suggests many of the essential points to be observed, and until replaced by a better term may well enough serve our need. (1927a, pp. 502-505.)

We have taken pains to discuss destructiveness, curiosity, and imitativeness in our subject Congo because of their conspicuous importance as conditions of behavioral adaptation and their very marked divergence from the conditions found in the other types of anthropoid ape. Our effort therefore has been to indicate characteristics of the gorilla as typified by the individual in question and to prepare the way for description of response to problems which demanded adaptation and in some instances habituation.

MISCELLANEOUS EVIDENCES OF INTELLIGENCE

As the few noteworthy contributions to knowledge of gorilla intelligence to be found in the literature are as intimately related to conditions of adaptation as to the phenomenon itself, we present them herewith in supplementation of the foregoing section and as prefatory to the account of our experimental study of intelligence in Congo.

Slyness, craft, and cunning are terms used by Falkenstein in characterizing the behavior of his young captive. Students of animal behavior will immediately appreciate the far-reaching significance of this author's generalized description:

> Of all his peculiarities which sharply stamped his individuality his good-nature and slyness (acuteness) or peculiar roguishness deserve to be emphasized. If he had been chastised, as often happened at first, he never resented the punishment, but came up pleadingly, grasped one's feet and looked up with such a characteristic expression that he disarmed every complaint; if he wanted to get anything no child could have made known his wishes more urgently or more winningly. If in spite of that his wish was not granted, he had recourse to stratagem, and spied out craftily to see if he were observed. Already in such a case, in which he with perseverance followed a fixed idea, a prepared plan and correct deliberation in execution were unmistakable. If, for example, he wished to go out of the room, or in returning, not to go into the same one, and if several attempts on his part to carry out his wishes were frustrated, he appeared to resign himself to his fate, and would lie down not far from the door with feigned indifference; but soon he would lift his head in order to assure himself whether the opportunity were favorable, shove himself gradually nearer and nearer, while, keeping a careful lookout, he turned round, facing cautiously toward the threshold, and peering stealthily up, and then, springing over it, he would gallop away so hastily that one had difficulty in following him. (Falkenstein, 1879, pp. 153-154.)

Wholly confirmatory of the observations of Falkenstein are those cited by Sokolowsky (1908, p. 33), on the authority of Zenker. When an adult gorilla, it is said, sees that an enemy is stronger than he or is otherwise at an advantage, he may disappear instead of attempting to attack, and hide in order to approach his antagonist from behind and in effect to surprise him. From this type of observation it may be inferred that the gorilla, although extremely powerful, does not blindly and recklessly rush into danger, but as circumstances dictate controls himself and has recourse to stratagem.

Our own observations furnish additional evidence of slyness, cunning, and strategic cleverness, but we have nowhere discovered in the literature confirmation of the observation and inference which Sokolowsky attributes to Zenker.

Although Carpenter in reporting on behavior of the captive "Empress" has little to say about intelligence or adaptivity, what he does offer more nearly agrees with the account given by Falkenstein than with that of Milne-Edwards, as previously cited (p. 493). Pertinent to our present informational search and interesting as indication of similarity between chimpanzee and gorilla is Carpenter's brief description of the behavior of his young gorilla in connection with medical treatment:

> The Gorilla [Empress] was very docile. She was willing to take any kind of medicine that might be prescribed by one of her several "physicians in ordinary." Supple remarked that she showed great intelligence in responding to his wishes in these matters, and that her leading motive in drinking a dose seemed to be a desire to please him. (Carpenter, 1917, p. 129.)

Unfortunately the extended opportunity of Cunningham for observation of healthful and contented captive specimens of lowland gorilla has yielded meager report. Prompt adaptation of the captive "John Daniel" to conditions of life in the Cunningham household is indicated, and below we quote description of two incidents which the author considers indicative of cleverness, or, in our present terminology, intelligence.

One day we were going out, for which I was sitting ready dressed, when John wished to sit on my lap. My sister, Mrs. Penny, said:

"Don't let him, he will spoil your dress."

As my dress happened to be a light one I pushed him away and said, "No." He at once lay on the floor and cried just like a child for about a minute. Then he rose, looked round the room, found a newspaper, went and picked it up, spread it on my lap and climbed up. This was quite the cleverest thing I ever saw him do. Even those who saw it said they would not have believed it had they not seen it themselves. Both my nephews (Major Penny and Mr. E. C. Penny), his wife and my sister (Mrs. Penny) were in the room and can testify to the correctness of the above record.

Another clever thing John did, although I suspect this was due more to instinct than downright cleverness. A piece of filet beef steak had just come from the butcher. Inasmuch as occasionally I gave him a small mouthful of raw beef, a small piece of the coarser part of the steak was cut off, and I gave it to him. He tasted it, then gravely handed it back to me. Then he took my hand and put it on the finer part of the meat. From that I cut off a tiny piece, gave it to him, and he ate it. When my nephew came home he wouldn't believe it, so I tried it again, with the same result, except that then he did not even attempt to eat the coarser meat. (Cunningham, 1921, p. 121.)

Without knowledge of the previous experience of John Daniel, and especially of such influences as may have prepared him to respond adaptively to the two types of situation described by the author, it is impossible to evaluate his behavior in terms of intelligence. Assuming that he came to the situations without specific preparation for appropriate response, his successful adjustment in each case suggests ideational processes and justifies the use of the term insight.

Presumably the relative dearth of observations on gorilla intelligence is due to the rarity of opportunities for study of this animal, the unfavorable psychophysical condition and uncoöperativeness of many captives, and the peculiar difficulties of experimentation. Fortunately our study of the behavioral characteristics, and especially of adaptivity and memory, in the mountain gorilla Congo enables us in the following pages to supplement in a measure the deficiency of the literature, and to supply at least as adequate a picture of the psychobiological traits of a specimen of *G. beringei* as is available for any comparable specimen of chimpanzee or orang-outan.

CHAPTER FORTY-TWO

METHODS OF STUDYING BEHAVIORAL ADAPTIVITY IN GORILLA

THE mountain gorilla Congo was available to us as scientific subject three successive winters. At the beginning of our work she was estimated to be five years old. During each winter approximately two months were given to intensive work with her. It was hoped that her psychophysical development might thus be followed through childhood to maturity. Our primary objective was an inclusive survey of mental traits. As far as possible, observation was conducted under experimental conditions, and these in the main were arranged to elicit affective response and behavioral adaptations. During the course of the investigation at least two-score problems and variants were presented in order to exhibit modes of adaptation or methods, rate, and limitations of learning. The layman would undoubtedly designate many of our procedures as "tests" of intelligence, but from our point of view they were instead experimental procedures to reveal the nature of gorilla adaptivity and to afford opportunities for reliable observation and measurement.

The essential principles of experimentation may thus be summarily stated. Each type of problematic situation demanded of the animal, as condition of success, a more or less complex series of acts which involved either adjustment to the immediate environment or adaptive modification of environment. Effort toward adaptation was motivated by a visible reward, usually food. Speaking nontechnically, the animal worked in our experiments for its board! Each experimental problem was so planned and presented that the observer could control conditions within certain limits, could check results in a variety of ways, could repeat his observations at determined intervals, and could systematically follow the course of development of adaptation throughout its history. Provided for also was suitable opportunity to record accurately and immediately what was observed.

The problems presented to Congo were intentionally varied from the extremely simple to the somewhat complex, and from those which might readily be solved by use of the animal's natural equipment of acts to those which by contrast might be supposed to require a measure of insight or constructive imagination. Variety was planned for also, in order to afford the subject a wide range of opportunity, and one and all, the problems might be solved promptly and more or less efficiently (1) by process of trial and error and without insight; (2) with directness and immediacy, indicative of appreciation of relations and other forms of insight; (3) with evidence of anticipation, pre-adaptation, or foresight; (4) in the absence of unaided solution by any of the above modes of adaptation, by imitation, or (5) failing otherwise of success, by tuitional aid from the experimenter.

To afford more definite knowledge of the nature, variety, and degree of difficulty of the problems, several will now be briefly described in terms of adaptation demanded. Several types of situation were so arranged that the desired reward could be obtained only by the utilization of a stick as instrument. In some of the problems of this category the stick was in immediate proximity to the reward; in others, it was removed a considerable distance therefrom, and in yet others it was hidden from the animal's view and must therefore be sought. Several problems were so arranged that only by suitable manipulation of a cord or rope could the animal succeed in obtaining her reward. There were grades of difficulty also in this category, from relatively simple manipulation by direct pulling of rope to such ma-

nipulation of an available rope that the reward was brought into a given position, where by following a roundabout course the animal might obtain it.

Yet another group of problems demanded

Fig. 153. Site of Yerkes' experiments with Congo, estate of James Burbridge, Jacksonville, Florida. From Yerkes, Genetic Psychology Monographs.

suitable manipulation of food containers, among which were glass milk bottles, glass fruit jars, and tin cans. In certain of the experiments the containers were capped or covered so that an obstruction had to be removed before the food within could be obtained; in some instances the container was too small for the insertion of the animal's hand and the food therefore had to be emptied out. Although problems of this sort strike us as extremely simple, several of them proved to be real problems for Congo and afforded excellent opportunity for observation of the appearance and development of adaptation.

Mechanical problems constitute another group. Without exception they required manipulation of some such simple mechanical device as a spring bolt, harness snap, or padlock, as condition for the opening of a food-containing box.

Another important assemblage of problems involved the manipulation of a box or of boxes. The reward in this instance was so placed that it could be obtained only by suitable use of a single box, or, in other instances, of boxes pyramided, for approach.

Finally, there is a miscellaneous assemblage of problems, including various situations planned to elicit natural tendency to imitate man, for example, the use of hammer and nail; situations to elicit emotional response, as, for example, the presentation of a mirror which afforded the animal opportunity to respond to her mirror image; problems which displayed natural or acquired tendencies toward preference for one hand or one foot, and which furthermore in certain instances demanded the use of a particular member and therefore afforded opportunity to observe the nature and rapidity of adaptation; problems whose solution demanded the removal of some obstructing object or group of objects before the goal could be approached; problems involving delayed response and necessity for memory of a perceived situation, and, finally, problems of an indirect or roundabout course or route from starting point to objective.

Although several of the problems included were devised by us for our immediate need, many of them are adaptations of experimental procedures used by other investigators in the study of habit-formation in one type of organism or another.

We would now illustrate problematic situation and response by briefly describing three types of experiment, of which two involved the use of a rope as essential part of the environment, and the third the manipulation of a chain.

The first example is designated as the diagonal-rope problem. We anticipated that it would be solved easily by the animal and our expectation was justified. The problem was set by stretching a half-inch manila rope between two posts outside a grill of vertical iron bars, between which the animal could extend its arm to reach the rope. It was so arranged that it was 24 inches from the grill at one end and 36 inches at the other end. At the most distant point, and several inches beyond the reach of the animal, the reward was attached. Obvi-

ously the direct and efficient method of obtaining the reward was to grasp the rope at the point nearest the grill and to follow it along to the point of attachment of the reward. This is what Congo actually did. In the first trial she started, by natural impulse, to reach directly for the reward, but she inhibited this act before its completion, and going to the nearer end of the rope she succeeded with difficulty in grasping it, first with one hand, then with the other. Then she pulled hard, but as the rope gave only a little she released her hold. "She quit and climbing to the bench above the grill sat there watching me and occasionally beating her chest." (1927, p. 73.) A few minutes later she returned to the task and, as described below, promptly solved the problem.

She came back briskly to the grill and in a manner which clearly enough betokened determination and expectation of success, began to work systematically for the apple. She grasped the rope at the nearer end with her left hand and pulling it toward her grasped it also with her right hand. Then hand over hand she moved along the grill toward the more distant end of the rope and her reward. It was a somewhat difficult performance because of the obstructing grill, but she managed it well and in a few seconds had reached the southeast corner of the grill and was awkwardly trying to bring her right hand and arm into play. The corner post of the cage made this difficult. After three vain attempts she succeeded in thrusting out her arm, grasped the apple and drew it to her by pulling on the rope with her left hand. The apple was carried to the nest-room while I recorded her success in the solution of this problem. (Yerkes, 1927, p. 74.)

Subsequently this relatively simple problem was solved uniformly with directness and ease.

We turn now to a form of rope problem which is much more complex than that previously described, since it demands either chance discovery of certain essential relationship of the rope to other objects, or insight. The situation, designated as the hooked-rope experiment, has been thus described:

At the extreme corner of the south end of the base bar of the grill a hook with one-inch opening was placed, and at the extreme end of the north corner a screw eye one inch in diameter. Each was heavy enough to stand a pull of at least two hundred pounds. Directly in front of the middle of the grill, outside the cage, and seventy-two inches from it, a heavy wooden stake was securely driven into the ground. To this stake, three inches above the ground level, was attached an iron ring three inches in diameter. With the permanent fixtures thus arranged, I prepared for use a piece of one-half inch manila rope. To one end of this rope a three-inch iron ring was fastened. This ring was then slipped over the hook at the south corner of the grill and the other end of the rope was carried through the ring attached to the stake and thence through the screw eye at the north end of the grill, extending freely into the cage to a length of about one foot. The rope was now drawn taut and a brick was tied into it on the screw eye side of the stake, and between this stop and the screw eye a tin can to serve as food-carrier was securely wired to the rope. This can was four inches in diameter by six inches in length, with an aperture of approximately four inches. The apparatus as set was designed to give Congo opportunity to secure the reward of food by removing the ring from the hook at south end of grill and pulling on the free end or free arm of the rope at the north end of the grill. If she hauled on that arm of the rope without unhooking the ring of the other arm it availed her nothing, or if she hauled on the other arm the stop prevented her from wrecking the apparatus. Thus the problem was to discover the relationship of the ring-on-hook to the possibility of drawing the food-container within reach. (1927, pp. 75-76.)

The gorilla's attack on this problem afforded no evidence of insight. As it happened, during the first trial, and within a few minutes after she had begun work, the ring became detached from the hook and shortly thereafter Congo obtained the reward. As there was no indication that she perceived the relationship of ring to hook and intentionally removed it that the food might be drawn within reach, this solution was recorded as accidental and subsequent tests wholly justified the inference.

Our description relates that:

One feature of her initial attack on this problem is peculiarly interesting in relation to the previously described diagonal rope problem. When Congo first seized the carrier arm of the rope she began to haul it in hand over hand, reaching between successive bars precisely as she had done to good purpose in the diagonal rope situation. This procedure proved useless and she promptly abandoned it. (1927, pp. 76-78.)

Aspects of the animal's behavior in her fifth trial and in the sixth given on January 13, together with the experimenter's interpretation of behavior, we herewith present in quotation:

> The following day success was achieved more quickly but with no clear indication that Congo had associated removal of the ring with the possibility of drawing in the food-carrier. In the next trial there appeared a strong tendency to shift rapidly from one arm of the rope to the other, this doubtless being an effect of her discovery that success ordinarily followed manipulation first of the ring arm of the rope and then of the carrier arm. Teeth as well as hands were used in this trial in removing the ring from its hook.
>
> The performance on January 13 is worthy of somewhat more detailed description to indicate stages in the progress of adaptation. Congo attacked her problem with enthusiasm. She pulled first on the carrier arm twice, then on the ring arm, then back to the carrier arm which she again pulled twice; now to the ring arm, and by attention to and manipulation of the ring she freed it from the hook. This, according to my notes, is the first time she has manipulated the ring with indication of definite purpose and intent to free it from the hook. Having succeeded in unhooking the ring, instead of going directly to the carrier arm of the rope and pulling in her food she pulled once on the ring arm. Her next act was to take up the carrier arm and secure the reward. The total time required in this trial was seventy-five seconds.
>
> The problem thus far had elicited gradual as contrasted with sudden adaptation. There was an elimination of useless movements or errors on the basis rather of repeated trial than of understanding of the essential features of the situation. No evidence of insight or understanding had appeared. Although Congo had definitely solved the problem it seemed desirable to give her a few more trials in order to trace the further improvement of technique and the manner in which errors were eliminated.
>
> In the very next trial, after a few vain pulls on the rope, Congo gave attention to the ring and deliberately and definitely freed it from the hook. This marked the most radical improvement in technique yet noted. (1927, pp. 80-81.)

We may not infer that this problem was solved by perception of the essential environmental relationships and direct and appropriate adaptation thereto. Instead, success was gradually achieved by the elimination of mistakes. When approximately a year after the original solution of the hooked-rope problem Congo was again confronted with it as an experiment in memory, her response, although far from perfect, was clearly enough indicative of previous experience. We have thus summarized the case:

> It appears therefore that although her first response to this problematic situation, after an interval of one year during which she presumably had no experience with it or similar problems, was imperfect, she remembered the situation and was capable of prompt and perfect adaptation. It is important to note that in her tenth and final trial in this problem during the winter of 1926, she made several false moves and required approximately thirty seconds for success. Her achievements in trials 4 and 5 of the repetitional series are markedly superior to the best performance of the previous year. Hence it is fair to say that she not only remembered the solution of the hooked rope problem, but actually improved in adaptive ability during the year intervening between her opportunities for work. (1927a, p. 439.)

Congo was accustomed to be taken from her cage daily and fastened by a chain ten or twelve feet long to a large oak tree nearby. She therefore had abundant opportunity to become familiar with possible relations of her mooring chain to the trunk and limbs of the tree and to acquire skill in unwinding or untangling the chain when her freedom of motion became restricted. On the assumption that problems which would interest Congo and exhibit her adaptivity might be set by winding her mooring chain more or less complexly about portions of tree trunks or posts, what we are about to describe as the wound-chain experiment was devised. It was initially presented during our first winter by winding the mooring chain twice about the trunk of a large oak tree adjacent to the tree to which the gorilla was usually moored for exercise. A plate of food was so placed that it could be reached only after the chain had been unwound. Although we had every reason to expect that Congo would promptly and readily solve this problem, she failed in two trials of fifty-five minutes and sixty minutes respectively during the first winter. As this result was surprising and puzzling, because it suggested inhibition of effort rather than

lack of ability to succeed, we re-presented the problem the following winter with result that Congo immediately solved it. Subsequently we discovered that whereas she would promptly and with obvious ease and eagerness unwind the chain, even when it formed a very complex figure about the adjacent portions of the trunk of her familiar mooring tree, she usually would refuse to attempt to unwind it when it was placed about the adjacent and relatively unfamiliar tree. Her behavior was even more puzzling to the experimenter than it had been initially. We have previously (pp. 490-491) quoted at considerable length from our description of the gorilla's behavior when with the chain attached to the unfamiliar tree the experimenter endeavored to achieve maximal motivation. The result was success in adaptation.

We have used the wound-chain experiment illustratively because better than any other employed by us it exhibits the complexity and unpredictability of gorilla response. It is beyond doubt that Congo knew how to unwind or disentangle the chain and that in any one of the trials she would have succeeded had she been adequately motivated. For the peculiar and unpredictable inhibitions of effort the most natural explanation is that the problem was originally set under a tree with which she was unfamiliar. Having initially failed of success in that particular situation she tended to be inhibited thereafter whenever that particular situation was used. On the other hand, she always solved the problem promptly when it was set under the familiar tree. Never have we observed in other types of anthropoid ape behavior comparable with that of Congo or suggesting conditions of inhibition and reënforcement which obviously influenced her.

Because the story of our experimental study of Congo is a long one we may not at this point offer additional illustrative materials but shall instead summarize our section by saying that the various problematic situations experimentally employed exhibited several modes of adaptation, while at the same time indicating relatively slow and inefficient problem solution.

Further description of our observations may most serviceably be offered in sections devoted to evidences of ability to use or construct tools, to operate simple mechanisms; evidences of memory, and, finally, evidences of constructive imagination—insight and foresight.

USE OF OBJECTS AS IMPLEMENTS; MECHANICAL ABILITY

When we first planned an experimental study of Congo we had in mind a series of problems which involved the use of objects as tools, for we assumed from our experience with chimpanzees that the gorilla would quickly learn to manipulate objects and might eventually acquire considerable skill in the use of tools, certain facility even in constructing them, and possibly also a considerable measure of mechanical ability. That our assumption was unjustified will appear from the brief review of the literature which is to be presented and also from the results of our experiments.

Mention of use of objects as tools or of aspects of mechanical ability in the gorilla are few and of little scientific importance. Those which we shall cite are typical, although not entirely consonant with other lines of information.

Reading (1884, p. 1278), in what is clearly mixture of truth and error, asserts that the gorilla cannot make a fire, builds neither house nor shelter, and in fighting uses as weapons only the defensive structures of his own body. "He will seize the gun or spear of his adversary and break but will not attempt to use it in his own defence." Essentially similar is the report of Garner (1896, p. 217) that the animal never puts two sticks together with the idea of constructing a shelter and that evidence is lacking that objects are thrown at an enemy. Assuredly Reading and Garner are mistaken about the construction of nest or shelter. Possibly they are correct in believing that objects are not ordinarily used by the gorilla as weapons.

Referring to the observations of Zenker, both Matschie (1904) and Heck (1922, p. 684) relate that often when the flies are troublesome a gorilla may break twigs from trees or bushes and holding them in his hand as he moves forward fan himself with them. Concerning this observation Heck remarks that if the possibility of imitation of man were ruled out, it would stand as an instance of use of object as tool. Undoubtedly the value of Zenker's statement depends on the frequency and reliability of observation. Another isolated instance of what may have been use of object as implement is cited by Lönnberg (1917, p. 17): a male gorilla was seen walking erect with a pole in its hand.

The pertinent statement of Akeley, referring presumably to the mountain gorilla, is overinclusive and fails to carry conviction. "The gorilla makes no abode, has no clothes, uses no tools, unless grasping a stick may indicate the beginnings of such an idea. It is still before the dawn of intelligence with him." (1923, p. 243.)

Poor indeed are the evidences for or against implement-using and mechanical ability in the behavioral literature on the gorilla. Numerous observations similar to those quoted might be presented, but they would add little to our knowledge by comparison with what may be readily obtained by well-planned experimentation. We therefore present in the following pages summary account of relevant experiments with the gorilla Congo. The first group of problems to be considered offered the animal opportunity to achieve desired reward by using a small stick in a simple manner. In the first instance, food was placed beyond the animal's reach on a shelf and one or more sticks were available in her cage. To our surprise in a series of trials she failed to solve this simple practical problem.

> During this initial period of experiment to test Congo's ability to use the stick as a tool it became increasingly clear that she had neither natural nor acquired ability to use sticks, straws, or functionally similar objects in her cage to aid her in reaching desired food. She used but two methods: the attempt to squeeze her head and body through the feeding aperture, and reaching with extended arm. To my great surprise there was no overt expression of excitement or anger because of difficulties encountered and failure to achieve the desired reward. She was hungry, evidently wanted the food, and yet acted calmly. Surprising also to the observer were Congo's poise in the experiment, her deliberateness of movement and adaptive effort, and her self-control and emotional stability. (Yerkes, 1927, p. 42.)

A second experiment consisted in placing food as reward on a platform outside a grill of iron bars through which Congo could readily reach. At one edge of the platform lay a stick. It would appear almost inevitable that a highly organized primate should secure the reward by grasping the stick and drawing the food within reach. But not so with Congo. For having seen the food placed on the platform she came directly to the grill and reached through it.

> Next she touched the stick with her right hand, but instead of picking it up and using it definitely she pushed it to one side and out of her way as if irritated by its presence. Not satisfied with merely pushing it off the platform, she continued until it was almost beyond her reach. (1927, p. 45.)

In this experiment also failure was recorded. Thereupon the experimenter attempted to show Congo how to solve the problem and thus to enable her to adapt imitatively; again failure. Finally, definite tuitional procedure was adopted in that the stick was placed in contact with the reward so that all the animal had to do was move it in the proper direction and the food would be brought within reach. The manner in which Congo profited by this opportunity for behavioral adaptation is of such peculiar interest and importance that we quote somewhat fully from our published description. The experimenter supplied imitative copy by pushing the apple about with the stick.

> After doing this a number of times I laid the stick down where Congo could reach it. At intervals I repeated this performance up to six times, but with no attempt on the part of Congo to imitate me. Finally, I pulled the apple toward the grill and left the stick lying with one end against it. Immediately Congo grasped the stick and in moving it chanced to move the apple also. It was just enough, however, to enable her to reach the reward. This, a fortunate accident, had marked effect.

After a few minutes I continued the copy-setting, using the stick to move the apple, then putting it down as above described. This was done about a dozen times without imitative response.

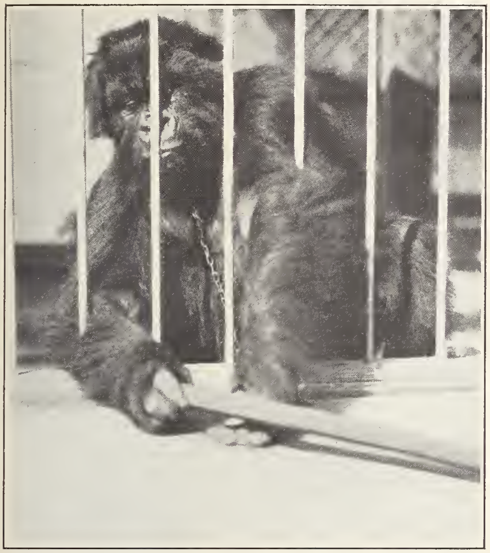


Fig. 154. Congo using a stick as instrument. From Yerkes, Genetic Psychology Monographs.

Then I again laid the stick down in contact with the apple. Congo immediately grasped the stick with her right hand and with it swept the apple to her left toward the corner of the grill and within reach. But even now when I laid the stick down apart from the apple she paid no attention to it. Evidently her natural tendency to imitate my acts was slight indeed. Prior to observation I had supposed that she would use the stick readily, if not by visual imitation, then by way of the tuition which this experiment provides.

The imitation test was varied somewhat on January 16 when I used small pieces of apple, usually quarters, and showed Congo that they might readily be moved about either toward or away from the grill by grasping and manipulating the stick. Whenever the stick happened to come into contact with the apple, or be left by me in that position, she eagerly seized it and swept the apple toward her left. If, however, the stick was placed on the left side of the apple, instead of the right side, she would make precisely the same motion, sweeping it futilely toward her left and there abandoning it. Although opportunity was provided many times in the course of this copy-setting, never once did she appropriately place the stick in relation to the apple and definitely direct its motion. The act of grasping the stick when it lay in contact with the piece of apple and at the right, and of sweeping it definitely to the left, seemed like an automatism.

The tuitional procedure was continued on four successive days, January 15 to 18, an average of fifteen minutes a day being devoted to the task. Ordinarily, Congo's attention was excellent throughout the interval and she undoubtedly would have worked much longer, if continuation had seemed advisable.

Struck by the value of Congo's behavior as evidence of the impossibility of properly describing or understanding an action except in the light of its genetic history, I arranged on January 19, with the coöperation of Mr. Ben Burbridge, to make a motion picture record of Congo's use of a stick to secure food. For the purpose of demonstration, a half orange was placed on the platform with the stick just to the left of it, from Congo's point of view. A record then was made of Congo approaching, grasping the stick, and sweeping it vigorously toward her left, and therefore away from the orange. I am not sure that the film shows any look of disappointment, chagrin or foolishness, but it certainly seems as though something of the sort should appear! In the next instance the stick was placed to the right of the orange and a record made of Congo grasping it and definitely sweeping the orange toward the left corner of the grill.

Anyone ignorant of the history of this behavior might naturally interpret the one act as stupidly

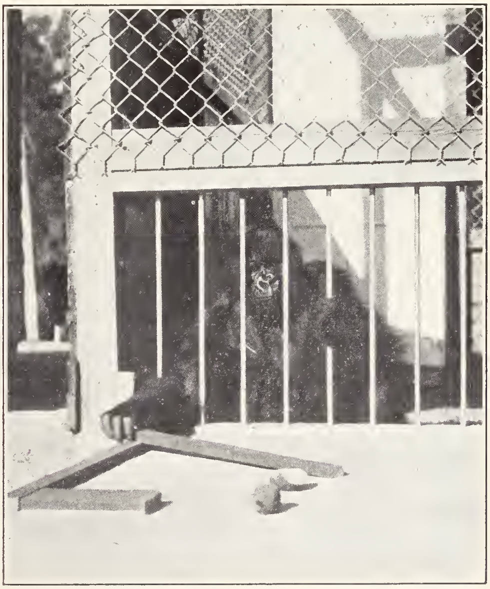


Fig. 155. Congo trying to reach an apple with a stick. From Yerkes, Genetic Psychology Monographs.

unadaptive and the other as definitely adaptive. Actually, as viewed in the light of the foregoing description, they differ slightly in value, and the one probably is neither more stupid nor more in-

telligent than the other. Indeed, Congo's persistence in sweeping the stick toward her left irrespective of its position in relation to the desired food was the most remarkable result of the experiment. (1927, pp. 48-50.)

Only after much fruitless endeavor and a great deal of practice did Congo finally succeed in using the stick promptly and skillfully to obtain a desired object which was placed on the platform beyond the reach of her arm. One cannot attribute her success to initiative, for she had opportunity to profit imitatively and also from tuition. Even after a considerable period of practice use of the stick continued to be very crude, consisting chiefly of pushing, throwing, jabbing, instead of well-coördinated, steady, directed movements.

Apparently she had her objective definitely in mind and knew what she wanted to do, but lacked the ability to make hand and eye work together. So great is her difficulty in using the stick that I am by no means sanguine that she will ever attempt to use it in other situations. It is hard, discouraging work; probably not less so to-day than when she originally achieved freedom from her initial automatism.

But the very next day she used the stick better than ever before and repeatedly secured bits of food in from thirty seconds to a minute. Her success heartened her greatly and her technique improved steadily and markedly. At times she placed the stick fairly well and made steady as contrasted with jerky movements. Either hand was used and apparently with no great difference in ease or skill. (1927, p. 53.)

The next phase of the stick experiment involved dissociation of the object from the immediate situation in which the reward appeared. The stick for example, instead of being placed on the platform, was located somewhere in the animal's cage within view of the platform. Congo gave no indication of association of the stick with the problematic situation, and after a few trials we recorded failure of solution. Thereupon we endeavored to teach her to seek, fetch, and use the stick whenever it was required. In our discussion of perception (p. 487) we have quoted a description of one phase of the dissociation of stick from immediate situation. After a time success was achieved in this experiment and Congo, when food was placed on the platform, would look about her cage and taking up an available stick carry it to the grill and use it effectively.

This particular series of experiments terminated with what we have called the hidden-stick problem, in which, as the name implies, the object to be used as tool was invisible and must therefore be sought by the animal. The result was that although Congo failed to work with high degree of directness and assurance, her behavior frequently indicated that what was "out of sight" was not necessarily "out of mind."

Differing importantly from the simple stick problems which we have considered is one in which a wire, stick, pipe, or rod might be used as implement to secure food concealed in the middle of a section of iron pipe which was fastened to the ground. We considered this also a simple, relatively easy problem and expected the gorilla to solve it on her own initiative and with promptitude. Such however was not the case, for she failed to exhibit any signs of approaching adaptation. Attempts of the experimenter to assist her by setting imitative copy yielded negative results, and even definite tuitional efforts, in which the experimenter placed the implement at or actually in the end of the pipe so that all the subject was required to do was push it through and thus force the reward out the opposite end, were unavailing.

In the meantime Congo had learned to use a stick in the platform-stick experiment and it was thought that her ability might transfer to the pipe and stick problem. This did not happen, although evidence of increasing interest in the stick appeared, for at times Congo would take it up and hold or carry it about with her, or again she would grasp the stick and, looking at the pipe, hesitate as though puzzled and baffled. One might interpret this behavior as indicating an early stage in adaptation.

During the second winter this type of problem was presented in a slightly different form by use of a long wooden box open at both ends and a heavy wooden pole in-

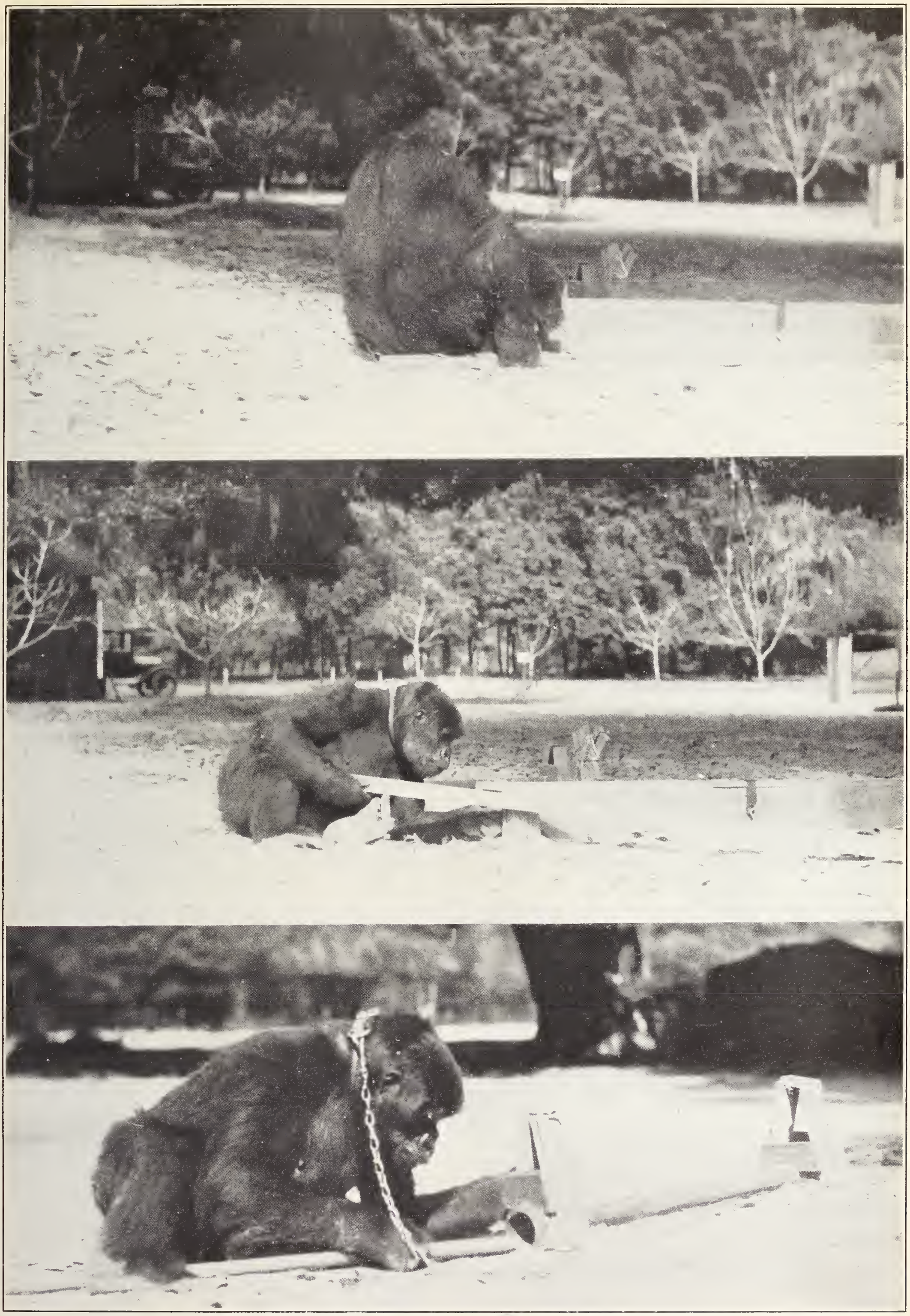


Fig. 156. *Upper.* The box and pole problem. Congo standing on her head as she looks through the box. *Middle.* Manipulation of pole in the box and pole problem. *Lower.* The pipe and rod problem. Congo on the threshold of success. From Yerkes, Genetic Psychology Monographs.

stead of pipe and stick. Once more Congo failed to solve the problem unaided. When the experimenter provided imitative copy by showing her how the food could be obtained, she manifested steadily increasing interest in the pole and attempted to use it.

Even after Congo had thoroughly mastered the handling of the pole when once it was properly entered, she found it extremely difficult so to orient it that she could insert it herself. This required a considerable amount of practice. In connection with her progress toward success, her behavior in trial (c) 14 is significant. The pole in this instance was initially placed three feet east of the box. Congo carried it to the north end of the box and there sat looking about. Presently she looked into the box and then tried hard to insert the pole, but she missed the opening and pushed it for some feet along the east side of the box. A little later she again attempted to insert it at the north end, looked into the box, looked at the end of the box, then at the end of the pole, paused, and then rather abstractedly handled the pole as though puzzled over its relationship to the box. This seemed very much like a reflective pause, and to the observer it naturally suggested approaching mastery of the problem. (1927a, pp. 419-420.)

After the box and pole experiment had been definitely mastered, primarily as result of tuition, experimental test was made of transfer of adaptation acquired in that particular situation to the essentially similar pipe and stick problem. For this purpose Congo was re-presented with the original pipe and stick situation. To our great surprise she promptly solved the problem. We have thus summarized results of this and similar experiments:

Evidence of transfer of ability from one problematic situation to a differing one appeared in two experiments: the shelf and stick and the pipe and rod. During the winter of 1926 Congo failed to solve the shelf and stick problem, although she mastered certain similar problems, but when the shelf and stick situation was re-presented after an interval of one year, she adapted to it almost immediately and perfectly, presumably on the basis of her previous experience in similar problematic situations and by reason of transfer. An explicit test of transfer was made with the pipe and rod experiment after Congo had mastered the essentially similar box and pole experiment. The result was positive. In general, however, evidences of spread or transfer of acquired interests and adaptations were meager. (1927a, pp. 527-528.)

In a third assemblage of problems the box appeared as possible implement. In the simplest of the several problems suspended food might be reached by proper placement of a single box; a more complicated form of this experiment required that the box, because of unequal dimensions, be placed with its greatest dimension vertical; and in still more complicated problems, solution required that a pyramid be constructed in suitable relation to the goal.

Although this series of experiments is of unusual interest we may not take space for detailed description, but must instead summarize the results.

Boxes were not promptly used as implements by Congo in 1926, but encouraged by imitative copy and tuitional effort on the part of the experimenter, she finally achieved solution of the greatest-dimension and the two-box problems. The experiments revealed little initiative, originality, or insight. Similar experiments in 1927, some of them virtually repetitions of earlier ones, and others new to the subject, yielded more abundant positive results. The problems which had been solved the previous winter were met with surprisingly adequate response on re-presentation. Indeed, it was clear that she had continued to improve during the rest interval. New problems, involving the use of three and four boxes, demonstrated an increase of adaptivity over that of 1926, while also proving that each additional box essentially alters the situation and tends to render it problematic. One might naturally suppose that having learned to pile one box upon another in order to reach a desired reward, an animal physically capable of the task would use additional boxes as necessary and available. Such was not the case for Congo. (1927a, pp. 528-529.)

This general statement we beg to supplement by fragments from descriptions of Congo's behavior in particular experiments; we quote first from account of her first repetitional trial in the problem of two boxes.

Congo ran directly to the larger box and rolled it over three times toward the center until it was in excellent position for use. Then she hastened directly to the smaller box, paused a moment to sit on it, and taking it in her arms carried it to the larger box, placed it squarely upon the latter, mounted the pyramid which she had thus constructed, and without difficulty reached the bag of food. The whole performance occupied somewhat less than one minute. Her technique was perfect

and the only obvious possibility of improvement was the elimination of the delay at the smaller box when she stopped to sit on it as if interested in the feel of it. (1927a, p. 465.)

Fig. 157. The use of boxes as instruments. Congo at work. From Yerkes, Genetic Psychology Monographs.

And a part of our description of trial 7 in the experiment with three boxes:

She came to the experiment eagerly, and after several minutes of varied activity directly, and with definite intent it seemed, pulled 18 to center, drew 15 upon it, and reaching from the pile almost touched the reward. Encouraged thereby she nevertheless descended to the ground and, knocking 15 from 18, attempted from 18 to pull both 15 and 12 to her. She was able to get both in her hands simultaneously, but she failed to raise them. Her next move was to pull 15 upon 18 and then reaching down from 15 to draw up 12 and place it upon 15. The pyramid thus constituted was perfect and, instantly mounting it, she easily reached the bananas and, grasping four of them, sat down on 12 to devour them. (1927a, p. 471.)

By the presentation of simple mechanisms we endeavored to discover the extent of Congo's mechanical ability. Among the mechanisms employed for this purpose were the ring and hook of the hooked-rope experiment, the hasp and padlock, the spring bolt, the spring harness snap, and various simple latches and hooks which were attached to the doors about the cage and elsewhere. Our initial experience was with the hasp and padlock problem. This was set by placing food in a wooden box with hinged lid. Congo observed this procedure; then the lid of the box was closed and fastened with a padlock, which instead of being locked was merely hooked into the staple of the hasp. From our previous experience with chimpanzees and orang-outans we assumed that the gorilla would quickly discover how to remove the lock and open the box in order to obtain the desired food. Such was not the case, for despite a long series of tests the gorilla completely failed of her own initiative to solve this simple problem, and even when opportunity to imitate the experimenter was presented she adapted to the situation with extreme slowness.

Likewise, in the several other forms of experiment involving simple mechanisms, Congo initially failed to achieve adjustment

Fig. 158. A three-box pyramid constructed by Congo to reach suspended food. From Yerkes, Genetic Psychology Monographs.

and finally succeeded by imitation or as result of tuition. Conspicuous indeed were her mechanical inaptitude and extreme

slowness and imperfection of adaptation to simple mechanical devices. Our principal conclusions may be conveniently summarized in quotation:

> From the observational results presented in the foregoing pages it would appear that my earlier tentative conclusions relative to the narrowly limited mechanical ability or aptitude of Congo are wholly confirmed. Although in the winter of 1927 she succeeded in solving simple mechanical problems in which she had previously failed, this indicates, I believe, rather the combined results of general adaptation to experimental situations and maturation than increased aptitude for dealing with mechanisms or greater insight into their essential characteristics and relations. Also supporting the conclusion that she is mechanically inapt in a truly remarkable degree is the repeatedly confirmed observation that she gave almost no attention to such mechanisms as the locks, hooks, snaps, and like devices which were used about her cage, in the construction of experimental apparatus, and for mooring her to trees. A notable illustrative instance is the following. On the inside of the door leading into her cage was a light hook such as is used on screen doors, which served to hold the door closed after one had entered the cage. It might naturally be supposed that Congo could, if she had so desired, either thrust the door open by force or lift the hook out of its eye, but during my months of observation of the animal and daily use of this device to hold the door shut, I never once saw her manipulate it. Were this not a typical observation, I should report others. It is a clear case of mechanical inaptitude. The chimpanzee is highly gifted in this respect, as compared with Congo. I think the same statement might be applied to the orang-outan, but as I have not had opportunity to make strictly comparable experiments and should have to depend upon intimate experimental acquaintance with only one specimen, I prefer to limit the comparison as indicated above. (1927a, p. 458.)

If one were to gauge the capacity for behavioral adaptation (intelligence) of the gorilla Congo by results of experiments requiring the use of objects as implements or the exercise of mechanical ability, the rating would be low indeed by comparison with chimpanzee or orang-outan. Our observations indicate, first, that Congo almost wholly lacked natural ability to use objects as implements, and second, that such ability was acquired very slowly and imperfectly as result of imitative opportunity or other forms of tuitional aid. It is a necessary conclusion from these experiments that the gorilla, as represented by this individual, possesses relatively little mechanical aptitude and slight tendency to utilize objects as tools or so to manipulate, fashion, or construct them that they will serve any particular adaptive purpose. It is noteworthy that this general conclusion from experimental observation is in agreement with the statements which are to be found in the naturalistic literature and which standing alone are unconvincing.

To infer from the observations which we have reported and from the conclusion that the gorilla ranks low in ability to utilize objects as implements and to operate simple mechanisms that this genus of anthropoid ape possesses relatively little intelligence is entirely unjustified. For, however important they may be, the functions which have been considered are merely examples of adaptivity. They do not constitute intelligence, but instead contribute to it. Thus viewed, it is entirely possible that the gorilla, while being distinctly inferior to the chimpanzee in ability to use and fashion implements and to operate mechanisms, is superior to it in certain other modes of behavioral adaptation and may indeed possess a higher order of intelligence than any other existing anthropoid ape. We are attempting to indicate a possibility, without assertion or prophecy. It is a matter of common knowledge that man exhibits extreme diversity in mechanical and artistic aptitude and ability. There are those who are naturally gifted as artisans, but who almost entirely lack artistic abilities, and, by contrast, those who although geniuses in musical or graphic expression, are almost wholly destitute of mechanical constructiveness or like aptitudes. Possibly, then, gorilla and chimpanzee represent differing directions of behavioral development, and may more profitably be described in terms of differences and contrasts than by the simple and at present utterly inadequately based quantitative comparison "more or less intelligent."

CHAPTER FORTY-THREE

CONCERNING MEMORY, INSIGHT, AND FORESIGHT IN GORILLA

TO pursue a step further the considerations with which the previous chapter ended, we may observe that the interrelations of discovered modes of behavioral adaptation are little known. Tendency and ability to use objects as tools may or may not be closely related to mechanical ability. It is indeed probable that there are varieties of reproductive and creative imagination and their correlated activities which are very different from and possibly also independent of implement-using and mechanical aptitude. Hence the extreme importance of extending knowledge of gorilla intelligence by observation of response to other sorts of problem than those which demand use of implements or manipulation of mechanisms. As we have already suggested, Congo, although a moron in mechanics, may nevertheless be capable of various kinds of imaginative adaptation. All that the results thus far considered justify us in saying is that she is not mechanically minded.

Among the many problems used by us in exploring gorilla intelligence were several especially designed to exhibit memory. In general, they may be described as the brief presentation of a situation to which the subject was not permitted to respond adaptively or otherwise until after a predetermined interval, which ranged from a few seconds to many months. Thus we endeavored to discover whether the gorilla can remember, and if so, what and how long.

Diligent search of the literature has discovered to us no facts concerning gorilla memory and few dogmatic assertions or guesses. Of the dwarfed captive "Pussi" Grabowsky (1904, p. 257) in this connection writes:

> It is also peculiar that although this animal has never been struck during her stay here she always shrinks back and withdraws into the background if one unexpectedly lifts a stick or umbrella into the air near her cage. This fear would seem to indicate that she has been badly treated by her previous owners and it also speaks in favor of her good memory.

The picture thus presented will be familiar to all who have long carefully observed the manlike apes, for whether or not indicative of excellent memory it is characteristic. After contrasting the mentality of gorilla and chimpanzee, Sokolowsky (1908, p. 50) remarks that the former is the more sensitive to punishment, easily disturbed, and that it does not forget quickly. Incredible as it may seem, these statements are typical of what the literature contains by way of information on gorilla memory. Naturally we hasten to search elsewhere for knowledge.

During our three successive periods of work with Congo, evidences of mnemonic processes became increasingly varied, numerous, and significant. As briefly as practicable we shall indicate the nature of our experiments and of the results obtained.

Doubtful at first because the subject was so inexpressive of mental condition, we were finally entirely convinced by her behavior that she remembered the experimenter and also many experimental situations or aspects thereof, not only from day to day but for the maximum interval, approximately eleven months, between observations.

To illustrate we quote the following account of the animal's behavior when the experimenter re-presented himself after an absence of about ten months.

> On my return to Jacksonville, January 14, 1927, I at once went to see Congo. As I approached she came to the side of her cage and gazed at me intently and steadily. Surprised by the directness and duration of her stare I returned it. She seemed not in the least disconcerted by my direct and continued inspection, but for an interval of per-

haps one to two minutes looked me over carefully, and for a considerable time looked directly into my eyes. The fact is noteworthy because most animals will not meet the human gaze directly for more than a few seconds. There was no affective demonstration or other unmistakable sign that she remembered me. I take it, however, that her very marked interest in me on first appearance is indicative of memory. My suspicion, in this connection, was confirmed on the following day by the behavior described in subsequent paragraphs.

. . . .

I started to remove a wooden shutter which during my absence had been nailed over the grill at the easterly corner of the cage. Seeing what I was doing, Congo came and assisted by pushing against the shutter from within the cage. Her action was eagerly aggressive and at once aroused my suspicion of interest which had carried over from experiences in our experiments of the previous winter. No sooner had the shutter been removed and the grill thus cleared, than Congo hunted up a stick and bringing it to the grill tried to use it to obtain things outside the cage. This behavior convinced me of memory of certain experimental situations in which she previously had worked. (1927a, pp. 383-384.)

The following winter even more definite evidence of recognition of the experimenter became available (Yerkes, 1928, pp. 12-13). The interval of absence had as previously been about ten months. The experimenter, dressed as habitually for work with Congo, approached her cage unseen by her and accompanied by her caretaker in order that there should be two observers of the animal's behavior. On seeing the experimenter Congo immediately came to the side of her cage and thus approaching as near as possible to him uttered a deep growl-like sound, previously identified as indicative of satisfaction, and pressing against the netting of the cage protruded her lips as if in greeting. The caretaker, who had even better opportunity to observe significant aspects of the total situation than the experimenter, reports that this behavior was quite different from that evoked by strangers, and in his opinion definitely indicated that Congo recognized the visitor and was glad to see him. Certainly her subsequent actions confirmed this opinion, for she was obviously eager to have the experimenter at hand and either to work or play with or for him in accordance with the program of the day.

Repetition of experiments was definitely planned to indicate mental development and also memory. During the second winter of work almost all of the types of experiment used the previous winter were re-presented to Congo, and during the third winter, as far as practicable, the same procedure was followed. Although the intervals between these repetitions ranged from nine to eleven months, almost without exception the results indicated memory of the problematic situations and retention of ability to respond to them with facility and a considerable degree of adaptation. Often indeed there appeared evidence of progress during the interim between experiments. We shall more explicitly state results of the re-presentation of experiments by brief quotation.

Of response to problems involving the use of sticks the report of our second period of work states:

She possessed interest in sticks and other objects as possible implements, greater initiative, versatility, and inventiveness than in the winter of 1926, and also, it appears to me, somewhat improved insight, or approach to insight, into the nature and essential features of the problematic situations. (1927a, pp. 434-435.)

Thus even more than memory was demonstrated, for it appeared that adaptivity had actually increased between practice periods.

This was even more obvious in the case of problems centering about simple mechanisms, for

these several experiments very definitely indicate that Congo's behavioral adaptivity increased markedly during the year between observations. Her mechanical ability, initially meager, seemed only slightly greater after a year. The evidences of memory or persistence of effects of earlier experiences in the various experiments are abundant and wholly convincing. In almost every respect Congo's responses to mechanisms are inferior to those of the chimpanzee. (1927a, pp. 460-461.)

Also, and likewise, in the several forms of box problem evidences of memory and mental development appeared.

In reviewing the four box experiments of this section it is eminently worthy of note that Congo used boxes as implements much more readily and skillfully in the winter of 1927 than a year previously. Especially conspicuous was her memory for the use of the greatest dimension of a box and of two boxes simultaneously, and her very considerable imaginal and manual skill in properly placing and using either a box or boxes in problems 10 and 12 of the present series. (1927a, pp. 478-479.)

And finally, in general summary of the evidence supplied by repetition of experiments after intervals of nine to eleven months, we have written:

Evidence of mnemonic processes is supplied by all of the experiments with Congo; and in most instances repetition in 1927 of the experiments of 1926 definitely proved that effects of experience had persisted and that she resumed her work either where she had left it the previous winter or with indications that adaptation had continued during the interval.

It is needless at this point to review the varied evidences from the score or more of experiments. The only one which yielded either negative or uncertain results was the pipe and stick or rod experiment, and even in that it may be argued that Congo remembered her failure and therefore was in a measure prejudiced against the situation. (1927a, p. 498.)

A special form of memory test we have designated the buried-food experiment. Probably because of such unfavorable conditions as timidity, distraction, varied forms of inhibition, and inadequate motivation, for all of which the inexperience of the experimenter was largely responsible, the use of this particular experimental situation during the first winter of observation yielded first negative results, and finally positive indications of memory. The experimenter inferred from this experience that Congo's memory was slightly developed.

Since during the second winter this experiment proved more useful, it is worthy of description. The essentials of procedure were so to arrange things that Congo should observe the burial of a quantity of food in some unusual location, which however had definite visual landmarks. When the food had been completely concealed and all surface evidences of disturbance of the spot removed, Congo was returned to her cage. After a definite interval of delay she was again taken to the spot where the food had been concealed and under uniform conditions of observation given opportunity to respond, if capable of doing so, to the previous experience of seeing a reward concealed.

In this form of experiment decisively positive results were obtained after delays of at least forty-eight hours. A possible adverse criticism should be suggested. The animal may have been guided in some instances by odor of the food. This appears to us extremely improbable, but we failed to exclude odor cues, as, for example, by placing the food in a sealed container. We should, however, report that Congo's behavior afforded little if any evidence of olfactory influence.

Our appraisal of this experiment, and also the fact that evidences of memory appear after much longer intervals than forty-eight hours, are presented herewith.

This form of test is in a variety of respects unsatisfactory and in my opinion it is of slight value by comparison with more readily controllable types of situation. There is evidence that memory of locations in which food has been concealed persists not merely for forty-eight hours, but for several days. Thus, for example, when returned to some of the spots described in the above experiments after approximately a week, Congo exhibited definite memory of her previous experiences in those locations. Probably like responses would be exhibited by various other mammals. Consequently it is doubtful whether in this type of experiment the gorilla exhibits anything distinctive, peculiar to her species, or indeed strikingly different from that of organisms of much simpler neural organization and mental constitution. It is not intended to belittle this procedure as a crude test or method of sounding for memory, but merely to indicate that by comparison with other evidences herein presented the results of the buried food experiments of Köhler and the writer are of relatively little importance. (1927a, pp. 497-498.)

To exhibit forms or aspects of adaptivity and especially mnemonic processes, and also to afford opportunity for measurement of temporal span of memory, we devised what may be described as the delayed-response experiment. In its bare essentials the situa-

Fig. 159. Congo in a memory experiment. The letters *w*, *g*, *b*, *r*, designate boxes any one of which may contain food. From Yerkes, Genetic Psychology Monographs.

tion is thus describable. In the center of an area some forty feet in diameter was set a post to which the gorilla could be moored, with definite control of her movements on the part of the experimenter by means of a rope, chain, and pulley system. Approximately on the points of the compass and sixteen feet from this post were placed four wooden boxes, each with a closely fitting lid. These food or reward boxes were alike except in color: that placed to the north of the stake was white; that to the east, green; that to the south, black; and that to the west, red. As a matter of fact, for this particular experiment difference in color was unnecessary.

The experiment was carried out by attaching Congo to the leash which extended from the stake through a system of pulleys to the station of the observer. Thereupon, the experimenter, with Congo watching, went to one of the boxes with a plate of food and removing the lid, conspicuously transferred the food to the box. He then replaced the lid and returning to his observation station waited for a definite interval, termed the period of delay, and at the appropriate moment released the subject so that she might, according to her memory or otherwise determined desire, seek her reward in one of the four boxes. The initial choice was made an important matter, because ordinarily the reward was either an entire meal or a goodly part of one, and except in certain special instances only one choice was permitted prior to another period of delay.

Preparation for the experiment was made by thoroughly accustoming Congo to the general situation and acquainting her with the fact that by going directly to a box in which she had shortly before seen food de-

posited she could readily obtain it. When she had learned to operate the simple rope and pulley mechanism readily and to go directly to a box when released, regular experimentation was undertaken. At first the interval of delay was five minutes, but since Congo chose correctly with evident ease and assurance the period was steadily and rapidly increased. We have thus briefly characterized the subject's early responses in this experiment and her attitude toward it.

Congo's initial responses surprised me greatly, for she chose correctly with evident ease and assurance, although during the period of delay she made no attempt to hold her orientation and apparently attended to the varied happenings about her as though unaware of the near presence of food. The chances of a correct choice, aside from memory, would presumably be one in four. Actually, she chose incorrectly about once in four times, and even then she almost never failed to locate the correct box on first repetition. (1927a, p. 486.)

Congo's prompt adaptation to the conditions of this experiment and her well-nigh perfect performance throughout the course of the work, doubtless will surprise the reader no less than they did the experimenter. Where discontent and impatience had been expected, she exhibited placidity and willingness to await her opportunity; and whereas attempts to destroy the mechanism and constant interference with its operation had been anticipated, these failed to appear. From the start the task seemed to appeal to her as interesting and worth while, and despite the rapidly lengthening periods of delay she worked quite as well at the end of the series of trials as at the beginning. Usually the motivation was adequate; I think I might safely say optimal. In this experiment, on many of the days of its continuance, Congo obtained at least half of her daily ration and at times almost the whole. (1927a, pp. 488-489.)

Within a week the period of delay had been increased to one hour and the gorilla still responded correctly and with little if any indication that it was more difficult to select the food-containing box after sixty minutes than after five minutes of delay. Up to this point in the series of experiments the subject had been permitted to wait at the mooring post undisturbed or undistracted by the experimenter throughout the period of delay. In the thirtieth trial the conditions of the experiment were radically changed, for Congo was removed from the situation as soon as she had seen the food placed in a certain box, and during an interval of two hours was elsewhere occupied, either with experiments or at play. When returned to the delayed-response experiment at the appropriate time she at first chose incorrectly and only on second trial obtained the reward. Subsequently, however, she very clearly demonstrated ability to remember the location of the food and to choose correctly even when removed from the mooring post and distracted by other experiments during the period of delay. The experiments finally indicated that she could respond correctly, whether or not distracted during the interval, after delay of as much as three hours. This is not a limit or definite measure of temporal span of memory because the experiment could not be continued.

We have thus commented on the possible significance of evidences of memory afforded by the delayed-response experiment and our other procedures.

Presumably several sorts of mnemonic process and imaginal experience existed in connection with the behavior which has been described. It is not possible to describe them in terms either of sense mode or of neurological process. There is risk possibly of over-estimating the importance of the relatively long periods of delay during which the gorilla could retain the psycho-biological condition necessary for correct reaction to a situation. It is rather the behavior of the animal during the period of delay and at the moment of decision and choice than the duration of the delay that impresses me as of peculiar significance.

In memory, as far as exhibited, Congo seemingly compares more favorably with the chimpanzee and orang-outan than in speed, versatility, and efficiency of adaptation to problematic situations. I have already demonstrated in a series of observations which will shortly be published, that the chimpanzee not only endures as long delays as did Congo in the delayed response experiment, but that it also reacts as readily and decisively. It may well be suspected that the delayed response of the gorilla, as of any other organism which can successfully withstand long intervals, has as neurological basis a physiological condition or process which is lacking in the rodents, and possibly in all of the mammals except the primates. One may naturally enough suppose that the capacity for

Fig. 160. Congo, moored to stake in memory experiment, waiting impatiently. From Yerkes, Genetic Psychology Monographs.

correct response after hours, days, weeks, or years of delay may be due to the physiological equivalent of imaginal or other representational processes and that such processes occur only in organisms of highly complex nervous system. If this proves to be true, it will doubtless also appear that such types of mnemonic process as are necessary to imaginal response, condition alike ideational adaptation and the forms of memory response which I have demonstrated in the gorilla and the chimpanzee by means of the delayed response experiment. (1927a, pp. 499-500.)

In describing the delayed-response experiment we intimated that color difference of food-containing boxes was unessential. This was indicated by demonstration that Congo's choice was influenced primarily by the location of the box and only secondarily by its appearance or by other features of the total situation. The question therefore suggested itself: Is the gorilla capable of remembering location of reward by color or some other particular quality of the food-containing box, and may correct response appear even when all other characteristics of the situation are changed? In an attempt to answer this question and thus further advance knowledge of the nature of mnemonic processes in the gorilla, we devised the form of experiment which we shall now describe.

On a platform beside the grill in Congo's cage a wooden turntable was set up (Yerkes, 1928, p. 29). On the periphery of this table some inches from the edge and equally spaced were placed metal cans which differed in color. The table was so placed that Congo by stretching her arm through the grill could reach it and grasping it with her hand turn it slowly either clockwise or counter-clockwise.

This apparatus was used for the study of memory response by teaching Congo, in the first place, that if she, after seeing food placed in one of the colored cans, rotated

the table until that particular can was directly in front of her, she would receive the food as reward. When she had become thoroughly familiar with the apparatus and

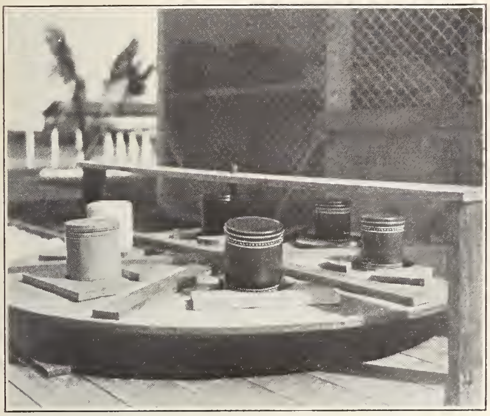


Fig. 161. Turntable apparatus for study of delayed response. From Yerkes, Comparative Psychology Monographs.

skilful in manipulating it, this procedure was introduced. A door between the table and the grill was closed and Congo was permitted to see the experimenter place some desired food in the can which was immediately in front of the grill. Let us assume for illustration that it is the white can. The experimenter then rotated the table so that the food-containing can was no longer in correct position; namely, directly in front of the grill. Following these preparations came a definite interval of delay, at the end of which the experimenter stepped forward, opened the door between table and grill and permitted the subject to respond by bringing the can which she desired to open into position directly in front of her.

In the early experiments failures predominated, but after a few days the gorilla became increasingly attentive and before beginning to turn the table looked at the cans intently as though in search of the correct one. With increasing frequency as the experiment progressed she succeeded after such visual inspection in turning the food-containing can into position and holding it there until she obtained her reward. The standard interval of delay was fixed at ten minutes, chiefly as a matter of convenience, but also because it was assumed that if correct response to color as indicator of food were possible after such an interval, it probably would occur also after much longer delays. In other words, we were interested initially in demonstrating the possibility or impossibility of memory response to color as contrasted with location or total situation.

We consider this experiment peculiarly important because it apparently has demonstrated that the gorilla can respond on the basis of mnemonic processes to isolated sensory data or perceptual fragments as well as to a complex situation which is perceived as a whole and in all probability responded to without analysis. Our experimental procedure artificially simplified the response-demanding situation and it might very naturally be supposed that when the position of the food container is changed and the nature of its surroundings radically altered, the animal would have great difficulty in locating it by the single distinctive visual quality of color. It is of interest to note that we have, at least tentatively, demonstrated the possibility of memory response to the isolated factor of color in delayed-response

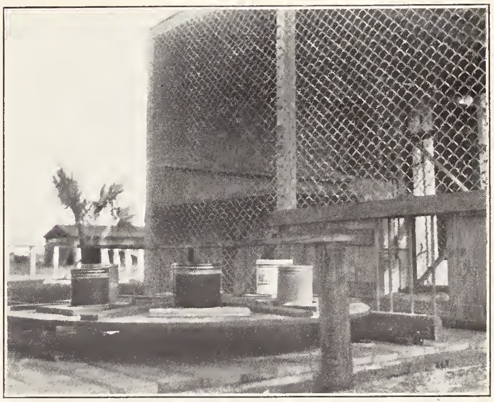


Fig. 162. Turntable apparatus and grill through which animal reaches to operate mechanism. From Yerkes, Comparative Psychology Monographs.

experiment for a chimpanzee as well as for a gorilla. The gorilla, however, adapted to the experiment more quickly and more

promptly succeeded in making correct choices than did the chimpanzee. (Yerkes, 1928, p. 48.)

CONSTRUCTIVE IMAGINATION: INSIGHT AND FORESIGHT

Whereas in the previous section we have considered what may with entire appropriateness be described as reproductive imagination, we would now attend to evidences of constructive and creative imaginal processes. There are among our experiments none which were designed for the particular purpose of revealing insight or foresight. Instead, from our varied observations of the daily life and activities of our subject and from modes of response to scores of experiments, we have obtained the observational evidences which are now briefly to be described, characterized, and discussed. Our exposition, which will be primarily by quotation from reports, will necessarily be brief.

Insight is used throughout this report to designate varieties of experience which in us are accompaniments of sudden, effective, individually wrought adaptations to more or less distinctly new and problematic situations. For us as students of animal behavior its indications are aspects of the adaptive behavior itself, and in our work the essential thing is to observe and accurately to describe the facts, irrespective of any interest or bias we may have respecting methods of learning or types of experience in the organism under observation.

. . . .

In acts which by us are performed with insight or understanding of relations of means to ends, we are familiar with certain characteristics which are important if not also differential. The following is a partial list of features of such behavior. It is presented here with the thought that the comparative study of behavior with insight, in different organisms, may reveal common characteristics.

(1) Survey, inspection, or persistent examination of problematic situation. (2) Hesitation, pause, attitude of concentrated attention. (3) Trial of more or less adequate mode of response. (4) In case initial mode of response proves inadequate, trial of some other mode of response, the transition from the one method to the other being sharp

Fig. 163. Motion picture of Congo operating the turntable in a memory experiment. From Yerkes, Comparative Psychology Monographs.

and often sudden. (5) Persistent or frequently recurrent attention to the objective or goal and motivation thereby. (6) Appearance of critical point at which the organism suddenly, directly, and definitely performs required adaptive act. (7) Ready repetition of adaptive response after once performed. (8) Notable ability to discover and attend to the essential aspect or relation in the problematic situation and to neglect, relatively, variations in non-essentials.

Some such list of characteristics or aspects of behavior with insight may ultimately serve as our criterion of such behavior, in the absence of definite and adequate knowledge of psycho-neurological events and their relations. It is unquestionably desirable that we continue to add to our list such observed features as regularly appear in human ideational behavior; and it is even more important that we make it our business to find out whether these characteristics are peculiar to ideational forms of response or appear also in other sorts of behavior. Without worrying unduly about objectivism or subjectivism, introspection, or other modes of observation, we may proceed with an unprejudiced study of the facts of behavior, profiting as much as may be from observation of our own experience and its varieties of expression, and following carefully, critically, persistently, the course of adaptive process in our animal subjects by means and methods which, as above suggested, should be relatively independent of the observer's limitations.

I hold no brief for ideation, insight, understanding, or any other variety or assemblage of experiences in my subject Congo, but I consider it a part of my descriptive task to state in direct, simple, and intelligible manner, what happened in the experiments. The observations have confirmed my suspicion that the conventional formula for habit-formation is incomplete, and the process of "trial and error" wholly inadequate as an account of anthropoid adaptations.

The foregoing descriptions of Congo's behavior must have impressed the reader with the frequency of failure and apparent stupidity where those who are familiar with the chimpanzee and orang-utan would naturally expect success, and perhaps also suggestions of understanding. I admit surprise at almost every turn in my study of the animal. This is one of the chief reasons for the length of this report. It has seemed that I must make clear to the reader the grounds of surprise, and as well as I could, the relations of the successive events which progressively enlightened me.

In the forms of the stick problem with which Congo was from time to time faced, a few responses stand out as possibly involving ideation. All have been mentioned in the previous chapters, but it may be excusable to review them here in what I consider their appropriate category.

Indication that "out of sight" is not necessarily "out of mind" is found in Congo's search for a stick when none was visible, and in her attempt to use as a means of egress the narrow ventilating space on the east side of her nest-room which only occasionally was open. Such behavior might be either ideational or non-ideational, but I maintain that its observable characteristics would differ markedly in the two cases. This is not the place to re-examine such characteristics as were actually noted. Among them are several of those mentioned in a previous paragraph.

The use of the stick as a tool presented convincing evidence that visual configurations are important. I was especially impressed by the fact that Congo became interested in the particular stick which was provided in the platform-stick problem only when, and seemingly because, it was in contact with, and therefore a continuation of, the food which she desired to obtain. Slowly and with extreme difficulty she finally acquired the ability so to manipulate the stick as to make it continuous with the food. But even then efficiency was lacking because it was as likely to be moved in the wrong as in the right direction when it came to pushing or drawing the desired object toward her. On the whole I saw numerically and qualitatively more evidences of what superficially seemed like random trial behavior than of what would naturally impress one as carefully planned and definitely directed effort to achieve a certain end. Yet in us just such behavior may express a motivating idea.

In the various box problems the outstanding evidences of insight were the suddenness of success, the relative initial skill in placing a box with its longest dimension in appropriate relation to the food, and finally, the extraordinary indication of "good judgment" in placing one box upon another. Neither one nor all of these acts would be likely to convince objectively minded observers that Congo really understood her problem and had definitely thought out ways of solving it. I do not pretend to know, and I am not arguing the fact. It is solely and simply a matter of appearances, and they, I contend, are strongly suggestive of a measure of insight. If, however, we deny the experience of insight in Congo, we should deny it also in human infants and children, when, as often happens, the appearances are the same.

The orang-utan, from whom I learned most, once tried to use me as an aid in solving a problem. I should be distinctly beyond the observed facts if I inferred that he expected something of my intelligence, but it seems wholly fair to say that he accepted me as a fitting substitute for a pole, ladder, or box. Whereas Congo never happened to exhibit this particular interest in one who was standing by in her suspended-food experiments, she did in other connections, as previously described, show similar behavior, for her attempts to induce the experimenter to leave her cage when

she desired to have the mirror to herself, or to have food placed on the platform so that she might reach it, were as intelligible as speech could make them. It was the appearance of this sort of behavior in various connections which first made me suspect a development of craft and cunning in Congo far beyond anything I had previously noted in other anthropoid apes. And although it would be inappropriate on the basis of my present scant knowledge to discuss the matter at length, I have also the suspicion that her degree of penetration and practical understanding of her environment and of the transformations in it for which I was responsible, far exceeded that made apparent by my descriptions of experiments. Much of the time she made me feel that she was concealing rather than revealing her insights. (1927, pp. 155-159.)

Yet another species of "evidence" is difficult alike to describe and evaluate. I have in mind inter-test activity. Whether it is implicit or explicit behavior I do not know, for I have not observed it. Something, however, happens between trials or experiences in a given problem which materially affects the nature and rapidity of adaptation. Presumably it is analogous to what is known to happen in human learning, for it has been demonstrated that the process of habituation occurs between training intervals as well as during those intervals. Scores of times in my experiments with other apes and with Congo I have noted that the solution of a problem or the development of a new method or a new attitude toward the situation progressed between trials, or as I have sometimes described it, over-night. I am by no means sure that this necessarily involves ideational processes. Instead I am inclined to believe that it is dependent on certain fundamental characteristics of neural tissue. But the fact nevertheless remains that the phenomenon has been observed most frequently and definitely in types of organism which possess elaborate and highly organized neural mechanisms, and which also exhibit marked ability to solve novel problems in seemingly ideational manner. Of course no thoughtful observer will miss the point that inter-test progress always makes it seem that the animal has continued to attend to the problematic situation, or think about it and its demands, when it was not present to the senses. Sometimes doubtless this is the case. Whether it usually or ever is in Congo I do not know. It seems distinctly worth finding out. (1927, pp. 160-161.)

In many of the tests I was far more impressed by Congo's lack of adaptiveness than by its presence or nature. Thus in the wound-chain experiment, she failed within the time allowed, although from her weeks of experience in being chained to trees and posts about the place, and from her evident interest in and ability to untangle or unwind a chain when it was fastened to a stake in certain experiments, I should have expected her to solve this problem promptly. So also in her habits of eating she was careless and seemingly unintelligent, in obvious contradiction to her occasional performance in other types of situation. Neatness, cleanliness, deftness and skill in obtaining and handling food are, I suspect, in general, indications of a high level or degree of adaptivity. The most intelligent chimpanzee I have ever studied showed these qualities conspicuously. Congo sometimes markedly lacked them. But it would be tedious and unprofitable to review evidences of stupidity. I have tried to do justice to them in the previous chapters and similarly in this to the positive evidences of adaptation with insight. It remains to give a circumstantial account of what I may designate as "warming up or awakening."

On several occasions during continued experimental work with anthropoid apes I have observed the phenomenon which I am about to describe as warming up. The striking thing about it is a sudden radical change in the animal's attitude toward its task and markedly increased effort and success. An illustrative instance was mentioned on page 50 when after the making of a motion picture record of the gorilla's behavior in the platform-stick problem there was an accession of energy and interest in the problem, coupled with initiative and sudden breaking away from the automatism which previously had been characteristic of her attempts to use the stick as tool. (1927, pp. 162-163.)

The phrase "warming up or awakening," previously used, is suggested by sudden and pronounced improvement in the subject's adaptivity and her altogether surprising success in solution of problems. This may be due in part to improved physical condition, in part to more favorable attitude toward work, and in part also to general adaptation to the experimental environment. We have commented on these several possibilities in the following paragraph:

Throughout the remaining days of my observation of Congo, the exceptional level of achievement which marked January 30 was pretty well maintained; and when on February 4 it was necessary for me to discontinue my observations I had the conviction that another month of continuous experimentation would have yielded indefinitely more illuminating results than did the initial period. It was Congo's increasingly favorable attitude toward the work itself that chiefly shaped my expectation. She seemed at last to have gained a certain general understanding of what the experimental situations were about, and, as a result of this functional equivalent of understanding or

insight, worked with greatly increased willingness, confidence of success, and persistency. Every critical reader will wonder whether she had discovered some cue to guide her to the solution of her problems. Naturally I thought of this and did my best to discover any conditions which might have helped her. I found none. (1927, pp. 167-168.)

And now we offer tentative appraisal of the imaginal aspect of our subject's behavioral adaptivity, based upon the results of our first period of study:

To sum up this too casual survey of evidences of ideation in Congo, I may say that they are fewer than I should have expected in the light of my experience with chimpanzees and orang-utans of comparable age. Evidences of other modes of adaptation than the ideational are more abundant. Also there are good indications that in Congo ideational adaptations are made with difficulty and extreme fatigue. It was chiefly for this reason that I doubted initially the possibility of working with Congo for as much as a half-day continuously. Probably her ability to work at several different problems in the same morning owes as much to her natural conservation of energy as to her splendid physique and constitution. She wastes very little effort, whether in muscular activity or in ill-directed attention. If a problem looks insoluble or a reward not worth working for, she inhibits effort. But when the account is finally cast, it is only fair that we recall that Congo's age is certainly not more than five years and probably less. In psycho-physiological development she is comparable with a young child. As I review my records of her behavior I am increasingly surprised, considering her age, by the amount and variety of her directed effort in the solution of novel problems, her patience, economy of effort, and steadily increasing ability to meet the general requirements of experimentation. Her relatively high level of intelligence, or adaptivity involving ideation, is evidenced by her general adjustment to the conditions of experimentation and her sudden solution of certain novel problems. (1927, p. 168.)

As a result of our second winter's work we thus modified and supplemented our previous descriptions and generalizations:

Although Congo in varied situations in which I have observed her during months of almost continuous work, adapted slowly, she nevertheless exhibited, the more clearly perhaps because of the slowness of her mastery of the problems, several different types of learning process. The following are more or less clearly and frequently manifested, sometimes in isolation, again in combination:

(1) Adaptation based upon reflex or automatized simple or complex acts, the elicitation and repetition of which in a given situation yielded satisfaction in the form of freedom, food, or other desired objects or opportunities for activity.

(2) Adaptation resulting from what to all appearances is random trial of different activities and the ultimate discovery and, finally, regular repetition of the particular act or succession of acts which yields satisfaction.

Both of these modes of response have repeatedly been exhibited and analyzed in lowly organized creatures, and are well described in numerous general works on animal behavior. They are exhibited by Congo, but because of other modes of learning, habit-formation, or adaptation, they tend to be overlooked.

(3) Differing from (2) in directness and possibly also in the nature of the neurological processes is a form of adaptation which involves inspection of the situation, with resulting exclusion of certain obviously possible acts and the limitation of trial to certain modes of response which more or less closely approximate adequacy. Finally, from among these acts, one which is not necessarily the most nearly adequate of all, but as a rule is highly adapted, becomes the preferred and regular mode of response. This variety of adaptation involves not only observation but discrimination and selection on the basis of previous experience.

(4) Adaptation with insight appears as a step in advance of method (3), for in it the organism, following observation of the problematic situation, exhibits immediately an appropriate act whose occurrence or use in the absence of previous familiarity with the situation indicates at least observational appreciation of some of the essential relations of the problem. In the previous mode of learning there is a measure of insight or an approach to it, but in the present mode insight is the conspicuous and all-important feature. In only a few of the problematic situations presented to Congo did she respond immediately and adequately. Perhaps the slot box experiment, problem no. 16, is as good an illustration of adaptation on the basis of insight as can be cited. But certainly the diagonal rope experiment, problem no. 11, and the auxiliary stick experiment, problem no. 6, supply excellent evidence of insight.

(5) So often do combinations of these modes of adaptation appear that it would be inexcusable to omit the category of mixed response. The use of automatisms, process of trial, inspectional analysis with a measure of insight, all may appear in the solution of any given problem.

All things considered, I must conclude that Congo has decidedly less insight in the types of problematic situation in which I have had opportunity to observe all of the great apes than has the chimpanzee or orang-outan, and although possibly this may be due to slower psycho-physical

development, I should be surprised if that proved to be the fact. As I review the score or more of experiments conducted during each of my two periods of observation, I am impressed first of all by the frequency of initial failure to master problems; next, by the slowness with which the gorilla profited by imitative and tuitional assistance, and finally, by the very limited, partial or slowly appearing appreciation of the essential features or relations of the problematic situations. Of her insight I have no doubt. Many times she gave impressive evidence of memory and anticipation of experiences, and although my primary interest is in the facts of behavior and their structural conditions, I still deem it altogether desirable, and from certain points of view of the utmost importance, to couple these facts with the phenomena of consciousness. (1927a, pp. 505-507.)

Thus far we have considered insight rather than foresight. There is an excellent reason. Evidences of insight are numerous; evidences of anticipatory response or foresight are relatively rare in our data. That they are not entirely lacking nor indeed likely to be overlooked by the experienced student of behavior we have thus intimated:

Memory of various objects and events was noted from day to day, and often anticipatory responses indicated that the gorilla, on the basis of her previous experience in problematic situations, expected certain happenings. For example, one morning when she was called to the cage door to be taken out for observation, instead of responding she went to the corner of the nest-room, from which she could see the trees under which several of the experiments were at that time being set, and very obviously looked over the situations. Perhaps she was looking for the rewards of effort which might be expected, or possibly instead she was interested in discovering which of the several problems were to be presented to her. In any event, marked interest in what was coming was evident in her attitude. This was observed on several days, as were also similar indications of anticipation of experiences. (1927a, pp. 498-499.)

Surprisingly few are the indications of constructive imagination in the gorilla Congo supplied by experiments which demanded mechanical ability or the instrumental utilization of objects. In such other types of experiment as those designed to reveal or measure aspects of memory, the indications of insight and foresight are decidedly more abundant.

REFLECTIONS CONCERNING INTELLIGENCE

As we consider attempt to express in a few sentences what is actually known, instead of merely surmised, about the psychobiological characteristics of the gorilla there comes to mind the endlessly repeated question: Is the gorilla more or less intelligent than the chimpanzee? Ordinarily questions are intended to express ignorance, but mayhap this one at times indicates more than is intended or desired. At any rate, from our present point of vantage it suggests ignorance of fact, a certain simple-mindedness and naïveté, or all of them, in addition to curiosity. As well one might inquire: Was Wilson more intelligent than Roosevelt, or Washington than Lincoln? For the term intelligence designates a complexly interrelated assemblage of functions, no one of which is completely or accurately known in man, still less in gorilla or any other anthropoid ape. It far better comports with our ignorance to ask wherein the gorilla differs psychobiologically from other primates, other mammals, other animals, or what, by contrast, are its distinguishing traits, than to request generalization.

Gladly we confess our ignorance of the relative intellectual status of the gorilla. In the face of the information at hand we should be equally reluctant to say that it is less or more intelligent than man, chimpanzee, or orang-outan. In fact, both statements may be true, since everything depends on the particular feature or aspect of intelligence which happens to be conspicuous. What we actually know, with considerable certainty, is that this anthropoid type differs importantly in many psychobiological respects from other primates. Some of these differences, together with many similarities, in comparison with man, chimpanzee, and orang-outan, we have set forth in the foregoing pages. Conspicuous among them are points in manner of life, social relations and sociability, disposition, prevalent affective attitude, tendency to affective expression, modes of expression,

natural interests and curiosity, imitativeness of other anthropoids and of man, instrumental use of objects, mechanical ability, constructiveness, memory, and foresight.

Many times in the course of our work it has occurred to us that this giant among apes may represent a natural experiment in which the value of brawn versus brain is being determined. We have speculated much on the evolutionary problems suggested by this idea, but we may not here pause to discuss the subject. Evidently Keith was thinking along similar lines when he wrote that man and gorilla, each variable and plastic, are evolving, "but in opposite directions, the one towards brain, the other towards brawn." (1926, p. 490.) Although obviously the preferred risk has been chosen by Keith, we should have been seriously tempted to substitute chimpanzee for man and to point the contrast between the two types of existing anthropoid ape.

From his intimate acquaintance with both gorilla and chimpanzee in their native habitats, von Oertzen carries further this characterization by contrast in stating that:

> The gorilla appears to me, although it is the highest of the apes, very like an animal which in its genetic development has been betrayed into a blind alley. For this anthropoid belongs to creatures with a double nature, which have acquired a little, never enough, of the many qualities needed in the world to carry on successfully the struggle for existence. It is not so circumstanced, within the boundaries of its natural gifts, that the species is assured of the greatest possible length of life. It is neither a skillful climber nor an enduring runner. It has the powerful jaws of an animal of prey, but nourishes itself on plant foods. It has the strength of the athlete, but prefers to save itself by flight rather than attack. Its means of speech are limited; its senses are incomplete. (1913, p. 7.)

Whether or not one of nature's partial failures or merely a stage in the progress from the dominance of brawn to the supremacy of brain, the gorilla it seems has not greatly increased in numbers and extended its habitat since its discovery by man. Instead, as von Oertzen intimates, it is a disappearing race. Of it, as of no other animal, we exclaim: Puzzling, baffling, yet intensely interesting and informing as object of psychobiological inquiry. The anthropoid trail lures us, but that of the gorilla has surprising fascination.

Our task of historical review and exposition is finished, for happily there are no more anthropoid types! We had come to feel, as we hope the reader has not, that the story was endless. In the concluding part and chapters of this volume we shall assemble facts for convenient comparison, and endeavor to suggest ways in which the anthropoid apes may be made to contribute signally to the advancement of human knowledge, understanding, and wisdom in the conduct of life.

From our general bibliography the following titles have been selected to indicate the chief sources of our information on the life of the gorilla: Akeley (1922, 1923, 1923a), Anthony (1912), Aschemeier (1921, 1922), Barns (1922, 1923), Bates (1905), Beddard (1902), Bischoff (1867), Bloch (1900, 1909), Bolau (1876), Bolk (1926), Bowdich (1819), Bradley (1922, 1926, 1926a), Brehm (1922), Broca (1869), Broesike (1877), Burbridge, B. (1926-27, 1928), Burbridge, J. C. (1926), Burrows (1898), Burton (1876), Carpenter (1917), Carus (1906), Cunningham (1921), Deniker (1891), Derscheid (1927), Du Chaillu (1861, 1867), Duncan (1877), Duvernoy (1855-56), Elliot (1913), Falkenstein (1876, 1879), Famelart (1883), Forbes (1894), Ford (1852-53), Franquet (1858-61), Garner (1896, 1900, 1914, 1914a), Gautier-Laboullay (1858-61), I. Geoffroy-Saint-Hilaire (1851, 1852, 1858-61), Gervais (1854), Giacomini (1897), Grabowsky (1904, 1906), Gray (1861, 1861b, 1861c), Gregory (1927), Grünbaum (1902), Gyldenstolpe (1923, 1928), Haberer (1908), Hagenbeck (1909), Hartmann (1872, 1880, 1883, 1885), Harvey (1917), Heck (1922), Hermes (1892), Hornaday (1904, 1915, 1924), Huxley (1863), Jenks (1911), Keith (1895, 1896, 1899, 1914, 1923,

1926), Knauer (1915), Kollmann (1885), von Koppenfels (1877, 1881), Lang (1924), Langle (1866), Lankester (1922), Lenz (1875), Leyton and Sherrington (1917), Lönnberg (1917), Lydekker (1897, 1904, 1910-11), Mahoudeau (1910), Matschie (1903, 1904, 1905, 1914), Maxwell (1928), Meyer (1876, 1881), Milne-Edwards (1884), Mitchell, P. Chalmers (1911, 1912), Mollison (1910-11, 1914-15), Nissle (1876), von Oertzen (1913), Owen (1849, 1859, 1865, 1866), Pechuël-Loesche (1882), Petit (1920, 1926, 1926a), Quatrefages (1866), Reade (1863, 1864, 1868), Reading (1884), Reichenow (1917, 1920, 1921), Rothschild (1904, 1906, 1908, 1923), Sanford (1862), Savage (1847, 1851), Savage and Wyman (1847, 1849), Scherren (1905), Schultz (1927), Sclater (1877), Smith, G. E. (1912), Sokolowsky (1908, 1909, 1915, 1923), Sonntag (1921, 1924), Sparks (1926), Tilney (1928), Trouessart (1920), Walker (1861), Waterton (1858, 1861), Wilhelm, Prince of Sweden (1923), Yerkes (1925, 1927, 1927a, 1928), Zeh (1915), Zell (1908).

PART VI

COMPARISONS AND CONCLUSIONS

COMPARISONS AND CONCLUSIONS

CHAPTER FORTY-FOUR

COMPARISON OF ANTHROPOID TYPES

THE expositional plan which we have followed in this volume of describing separately each type of anthropoid ape demands the supplementation of a comparative survey. The remaining three chapters are devoted respectively to (1) systematic comparison of outstanding traits of the principal anthropoid types, (2) similar but more general comparison of the psychobiological characteristics of primate types from lemur to man, and finally (3) summary consideration of anthropoid research in retrospect and prospect. Further, the chapters speak for themselves.

If we were beginning instead of finishing our work on this volume we should omit from detailed consideration the Hylobatidae (gibbons and siamangs), for we are now entirely convinced by psychobiological facts as well as by the morphological considerations of conventional taxonomy, that these primates should not be classified with the anthropoid apes. Instead they constitute a most interesting and distinctive group, consisting of the divergent types gibbon and siamang, between the Old World monkeys and the three existent types of manlike ape. But inasmuch as a special part of this volume is descriptive of the psychobiology of the Hylobatidae, it is clearly enough desirable to include them in our summary comparative survey. As far as practicable in this chapter, we shall differentiate between gibbon and siamang and between them and the manlike apes.

In the comparison of anthropoid types which follows, many facts, many significant characteristics, have necessarily been omitted. Selected for reëxamination are those which are useful for the identification of types or to indicate contrasts and suggest observational opportunities and unsolved problems. General summary of our Part I, on history of knowledge of the anthropoid apes, has been omitted from this chapter because a brief historical summary appears in each of the special parts: for gibbon, pages 47-49; for orang-outan, pages 103-104; for chimpanzee, pages 198-199, and for gorilla, pages 382-386.

For convenience of exposition the traits which we have selected as basis for comparison of the anthropoid types have been arranged in nine categories, beginning with the structural and concluding with the mental. Following the terminology used in earlier chapters they are designated: configurational comparisons, physiological characteristics, species and ecological relations, mode of life, social traits, life history, affective traits, receptivity, and intelligence.

CONFIGURATIONAL COMPARISONS

CERTAIN characteristics of *coat and skin* contrast conspicuously and aid the inexperienced observer in identifying anthropoid genus or species. The hair of the gibbon tends to be fine and woolly. In color it ranges from pure white to jet-black. Some individuals are concolored and others mixed. The color may change during life history and in a given species it may differ for the sexes. The skin is dark brown to black, smooth, soft, and ordinarily clean. The coat of the siamang, by contrast, is uniformly black and the hair is relatively coarse and straight. The orang-outan is characterized by light to dark reddish hair, usually coarse and straight, and skin which varies from light to dark brown with approach to grays and purples in mature and senile individuals. Variations are conspicu-

ous, but in general coat color is distinctive, as is also a gooseflesh appearance. The coat of the chimpanzee, which consists of coarse straight hair, varies from black to grayish. Usually the animal is concolored, although in old specimens the hair of certain regions tends to become lighter. The skin in some species and specimens is almost white, whereas in others it is light to dark brown. Ordinarily the hair of the gorilla is described as jet-black, but it is known to vary with age and sex and in different parts of the body, sometimes appearing reddish and again grayish. Old individuals are lighter colored and occasionally they are quite gray. The skin ranges from dark brown to black. With the exception of the gibbon, all of the anthropoid types are concolored.

Build and size distinguish the anthropoid apes almost as definitely as do coat characters. The gibbon is relatively very slim and tall for its weight, with well-developed chest and slender abdomen. Its height approximates thirty-two inches, its weight ten pounds. The arms are much longer than the legs and when the animal stands erect its fingers may touch the ground. Both hands and feet are long and narrow. Small ischial callosities are present. The siamang is somewhat more stocky in build than the gibbon and decidedly larger, for its height may exceed thirty-four inches and its weight twenty pounds.

The body proportions of the orang-outan, oddly enough, are the reverse of those of the gibbon, for although it is short and stocky it appears to be loosely built and the chest is less conspicuous than the abdomen. Height ordinarily ranges about forty-eight inches and weight approximates one hundred sixty pounds. The arms are very long and the fingers often reach to midway between knee and ground. The hand and fingers are relatively long and narrow and the thumb diminutive, as is also the great toe. There are no ischial callosities.

The chimpanzee more closely than the orang-outan and gorilla approaches man in the proportional development of chest and abdomen, but, like the other manlike apes, it is relatively short and stockily built. Its height centers about fifty inches and its weight approximates one hundred fifty pounds. The arms are relatively shorter than those of the orang-outan, although usually the fingers reach below the knees. The hand is broader and shorter than that of the types previously described, the thumb is small; the feet are relatively large, as is also the great toe. Usually it is said that ischial callosities do not occur, but in some captive individuals the habit of sitting induces a condition of the skin which closely simulates them.

Giant among the primates, the gorilla is huge of chest and abdomen, with great breadth of shoulders and back, a height of five feet, and a weight of three hundred pounds. Its arms and legs are heavy by comparison with other types, but in proportions closely approximate those of the chimpanzee. The hand is much broader and shorter than that of orang-outan and chimpanzee, the fingers more stubby. The foot also differs importantly from that of all other anthropoid types: the heel is conspicuous and the great toe strongly developed. Ischial callosities are lacking.

In general, the female anthropoid ape is considerably smaller than the male. The difference is most striking in the three manlike apes. Perhaps such general statements concerning anthropoid height and weight as we have presented in the foregoing paragraphs may best be safeguarded by the qualification that they may vary in either direction by as much as twenty per cent. The gorilla, for example, is likely to measure not less than forty-eight nor more than seventy-two inches in height, while in weight it may measure as little as two hundred or as much as four hundred pounds. Roughly, then, the siamang is about twice as heavy as the gibbon, the orang-outan and chimpanzee are of the same order of magnitude and approximate the size of man, while the gorilla is very much larger and may weigh twice as much.

Neck, head, and face, by their contours, greatly assist the observer in identifying

Fig. 164. Infant gorilla, Bamboo (left), and chimpanzee, Lizzie. Probably neither is far from two years old. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

anthropoid type and species. An obvious feature of the gibbon and siamang, the neck is relatively much shorter and thicker in the orang-outan and chimpanzee, and in the gorilla it is practically obliterated by marked development of the connective tissue, skin, and hair between back and head. Important as modifying the configuration of the neck are the laryngeal sacs which lie at its juncture with the chest. These sacs are absent in the gibbon, although present in each of the other types. In the siamang they are peculiarly conspicuous because the skin covering them is naked and shiny black. When the sacs are inflated in this creature its appearance is markedly altered. This description applies similarly to the orang-outan, for in it also the sacs, or rather the huge folds of skin which may cover them, are distinctive. When inflated they are like huge goiters, and even when deflated they are conspicuous. Although present in both chimpanzee and gorilla, the laryngeal sacs do not greatly modify the contour of the neck and it is said they never are inflated. According to morphological authorities the structure of the larynx, with which the laryngeal sacs are associated, increases in resemblance to that of man in the order: orang-outan, gorilla, gibbon, chimpanzee.

Head shape cannot be briefly characterized for the types. It varies from roundish to elongated or egg-shaped. The facial angle varies greatly with type and also with

age. It is relatively greater in the gibbon than in the manlike apes. But whereas the skull is relatively smooth, even in old age, in gibbon and siamang, in orang-outan and chimpanzee pronounced ridges and crests develop, and in gorilla they are tremendously exaggerated and constitute the most conspicuous features. It is stated (Tilney, 1928, II, 950) that the encephalic index increases in the order: gibbon, orang-outan and chimpanzee, gorilla, man. The figures for orang-outan and chimpanzee are the same.

The face of gibbon and siamang is roundish and in maturity in many ways more strikingly suggestive of the human than is that of any other anthropoid type. Peculiar to the mature orang-outan are certain growths usually described as cheek pads or cheek callosities which appear symmetrically on either side of the face. They are limited, it seems, to the male. Sometimes they become very large and the face is thus greatly broadened. An orang-outan with huge cheek pads and an immense fold of skin under the neck, covering the laryngeal sacs, is indeed striking in appearance.

In all anthropoid types the nose is a conspicuous facial feature. In gibbon and siamang it is small and slightly flattened, with downward directed nostrils, and closer resemblance to the human than in any other anthropoid. It is flat and broad in all the manlike apes. In the chimpanzee, in addition to being depressed, it commonly has a conspicuous median longitudinal furrow or groove. The nose of gorilla, by contrast with all other types, has a long bridge and broadens as it approaches the mouth so that its form is roughly triangular, with huge nostrils directed downward and outward. It gradually merges with the upper lip.

Often it is said that the external ear of gibbon, siamang, and chimpanzee is relatively large, that of orang-outan and gorilla small. Like most general statements this is somewhat misleading, for although almost invariably the ear (pinna) of orang-outan and gorilla is small and set close to the head, that of the chimpanzee may in certain individuals, races, or species be very similar. As a rule, however, it is large and conspicuously outstanding in chimpanzee, whereas in gibbon and siamang, although relatively large, it is rendered inconspicuous by the heavy hair surrounding it.

The eyes in all of the anthropoid types are so placed as to facilitate binocular vision. Authoritative description of color differences is not available. It is noted that in all types they are conspicuous facial features, often, if not as a rule, varying in color from light to dark brown and usually characterized as expressive. The mouth in each type is large, but only in the manlike apes do the lower jaws become so large and heavy that they markedly diminish the facial angle. The teeth are especially large, strong, and conspicuous in gorilla. Undoubtedly facial appearance is more markedly influenced by the size and contour of the lips than by any other features except supra-orbital ridges, nose, and ears. In gibbon and siamang the lips are roughly comparable with the human, whereas in orang-outan and chimpanzee they are larger, heavier, extremely mobile, and also protrusible. The upper lip is relatively long and the lower full and distinguishable from the chin. Either of these great apes is capable of protruding the lips funnel-like to a distance of some inches, or of extending the lower lip shovel-like. The lips of gorilla resemble rather those of gibbon than of orang-outan or chimpanzee. They are not pronouncedly mobile nor are they commonly protruded. The upper lip is short and inconspicuous because of the contour of the nose and the lower is relatively thin.

The foregoing comparisons, unless otherwise indicated, apply only to the adult individual. Together they should enable any intelligent observer to distinguish the several types of anthropoid ape and to identify a specimen as belonging to one or another. If, however, the specimen should be immature, difficulties are inevitable, for configuration changes markedly in most respects, and extremely in a few, between infancy and maturity.

Fig. 165. Gorilla, Bamboo (above), and orang-outan, Orphan Annie. Estimated ages two years and one year respectively. Photograph by Newton Hartman, courtesy Philadelphia Zoölogical Garden.

PHYSIOLOGICAL CHARACTERISTICS

Information is entirely inadequate for satisfactory characterization and comparison of anthropoid types with respect to physiological characteristics. Our description must therefore be very general and also incomplete and relatively inaccurate. We have selected for mention only those characteristics which offer contrasts.

Muscular and perhaps also neuromuscular strength appears to be relatively greater in the anthropoid apes than in man. Gibbons and siamangs are capable of continued and rapid locomotion over long periods, and measurement has demonstrated that orang-outan, chimpanzee, and gorilla are several times as strong as man. The anthropoid contrasts which may be pointed depend chiefly on size. The gorilla naturally possesses enormous strength, while in the gibbon and siamang it would be less misleading to speak of endurance. Orang-outan and chimpanzee in absolute strength are similar, and naturally fall between gorilla and gibbon. There is nothing to indicate that muscular and neuromuscular efficiency, or endurance, varies greatly from type to type. Contrast is, then, rather between anthropoid apes, on the one hand, and monkeys and man, on the other.

Vitality, viability, hardihood, and disease resistance suggest characteristics in which, to judge by common statement and popular opinion or superstition, the anthropoid types differ markedly. It might be inferred from the reports of hunters and zoölogical-garden authorities that the gibbon is least resistant to injury, unfavorable conditions of captivity, and disease. Next, despite its superior size and strength, comes the gorilla, for it is said to be readily killed by gunshot and to withstand captivity less well than either orang-outan or chimpanzee. Ranking next in order is the chimpanzee, and finally, as most resistant of all, the orang-outan. The comparison of orang-outan and chimpanzee, however, requires elaboration, for whereas the chimpanzee appears to be less resistant to physical injury and more readily killed by the hunter, it is rather more likely to survive in captivity and to resist various untoward conditions than is the orang-outan. We have discovered no justification for the characterization of any type of anthropoid ape as delicate. They are hardy and in varying degrees injury- and disease-resisting. But the probability of continuing normal existence in captivity increases, according to available evidence, in the order: gorilla, gibbon, siamang, orang-outan, chimpanzee.

Characteristics of glandular activity are difficult to discover in the literature. Lachrymal glands are said to occur in each of the types, yet because of morphological conditions and degree of secretory activity tears are not shed. The not infrequent assertion that the manlike apes weep is misleading. Sweat glands also occur in the several anthropoid types in varying abundance and with other peculiarities of distribution, but rarely is mention made in the literature of perspiration or of body odor attributable to it. On these points we have discovered no information relative to gibbon or siamang, and such observations concerning orang-outan as are available do not definitely indicate body odor due to sweat. With the exception of the species designated as Tschego, in which profuse perspiration with odor like that of Negro has been reported, the statements concerning orang-outan are applicable also to chimpanzee. By contrast with information concerning the other anthropoid types, that relative to gorilla indicates pronounced activity of the sweat glands and a strong musky or negroid odor which by several authorities is mentioned as distinctive of this ape.

Data relative to body temperature, respiration, and pulse are few and inadequate as basis for safe comparison of types.

SPECIES AND ECOLOGICAL RELATIONS

The order of increasing diversity within anthropoid types appears to be: siamang, orang-outan, gorilla, chimpanzee, and gibbon, for of reasonably well-defined species

siamang and orang-outan present one each, gorilla one or, at most, two, chimpanzee and gibbon at least eight each. The order of increasing frequency of varieties or races within a type, indicated by the imperfect data available, is slightly different; namely, siamang, gorilla, orang-outan, gibbon, chimpanzee. Possibly this is also the order of increasing structural variability, for with respect to such configurational characters as we have particularly considered it would seem that siamang, gorilla, and orang-outan are distinctly less variable than gibbon and chimpanzee. There are more or less convincing evidences of dimorphism, correlated with age, sex, or both, in gibbon and orang-outan, whereas homogeneity tends to prevail in siamang, gorilla, and chimpanzee.

Gibbon, siamang, and orang-outan are oriental types; chimpanzee and gorilla, African. Gibbon occurs in Southern China, the Malay Peninsula and Archipelago, and the Island of Hainan; the siamang in Sumatra and possibly also the Malay Peninsula. The orang-outan is found only in Borneo and Sumatra. The gorilla occurs in narrowly limited areas, the one species, or subspecies, in West Equatorial Africa, especially Gaboon and Cameroons, and the other in East Central Equatorial Africa and especially on the eastern border of the Belgian Congo. The chimpanzee is most widely distributed of all, since it is found over many thousands of square miles of Equatorial Africa from the west coast to the Lake Tanganyika region.

As notably different as their geographical distributions are the characteristic habitats of the anthropoid types. The gibbon inhabits upland forests to an altitude of approximately five thousand feet, and the siamang, although found in similar natural environment, unlike the gibbon descends to sea level. By the orang-outan low-lying swampy forests and wooded river courses seemingly are preferred. Unlike the Hylobatidae it does not ordinarily take to the hills or mountains. One or another species or race of chimpanzee is found in lowland plains, valleys, hills, and mountains of tropical Africa. All are forest animals and they are not known to occur at altitudes greater than a few thousand feet. In the case of the gorilla, habitat varies extremely with species, for *Gorilla gorilla* is a lowland form which frequents the tropical jungle forests of the Gaboon and Cameroons, whereas *Gorilla beringei* is a mountain species which inhabits the plateaus and mountains even to an altitude of nearly ten thousand feet in East Central Africa. All of the types exhibit marked preference for jungle and forest versus unwooded areas.

It is indeed difficult to indicate safely the frequency or abundance of these several sorts of primate. We hazard the opinion that the present order of increasing frequency is: gorilla, siamang, orang-outan, chimpanzee, gibbon. This rating is based upon the following facts. The siamang occurs as a single species in narrowly restricted distribution, while by contrast the gibbon is widely distributed and highly variable. Moreover in many regions it is said to be obviously abundant. Neither species of gorilla is frequently met with. Probably the total gorilla population does not exceed a few thousand individuals, and almost certainly the mountain species is more rare than any other type of anthropoid ape. Reports justify an estimate of one thousand individuals. In the hunting days of Schlegel, Müller, Wallace, and Hornaday, orang-outans must have been numerous, for the collectors obtained scores of them. Almost certainly the encroachment of civilization has restricted their distribution and probably correspondingly reduced their numbers. Basis for estimate of population is lacking, but we feel justified in asserting that these great apes probably are today much more numerous than the gorilla. Next in abundance to the gibbon is the chimpanzee, for it inhabits an immense territory and occurs in several species and varieties which collectors and naturalists find it not extremely difficult to locate.

Degree of success in life or in the struggle for survival presumably is indicated by size of population, area of distribution, and

diversity of type, but in suggesting as order of increasing success gorilla, siamang, orang-outan, gibbon, chimpanzee, we are influenced also by the varied psychobiological facts which constitute the principal materials of this volume. That gorilla and chimpanzee mark the limits of the series is of peculiar interest, since by many morphologists, and especially by students of the nervous system, gorilla is said to resemble man more closely than does any other animal. Nevertheless, while we have prospered and taken possession of the earth increasingly, the gorilla type has failed to extend its domain or to discover serviceable new modes of adaptation. Freed from the disturbing influence of man, it is easy to imagine chimpanzee and gibbon prospering exceedingly by reason of new structural, functional—and even psychobiological—adaptations, while gorilla and orang-outan either remained stationary or tended to vanish before the aggressive competition of other types of organism.

MODE OF LIFE

Great diversity appears among anthropoid types in that large assemblage of activities which we designate as mode or manner of life. Of the numerous forms and aspects of behavior which might be used to exhibit contrasts we have selected those pertaining to locomotion, posture, handedness, dexterity, nesting, eating and drinking, and response to captivity.

Locomotor and postural contrasts are of extreme interest to the student of genetic relations, for the anthropoid types represent, it would seem, transition from arboreal to terrestrial habit, and the following is fairly well established as order of increasing terrestrialness and diminishing arborealness: gibbon, siamang, orang-outan, chimpanzee, gorilla. Beyond dispute, gibbon, siamang, and orang-outan are tree dwellers. The chimpanzee appears to be almost equally at home in tree or on ground, but as it always frequents jungles and forests it must nevertheless be classified as an arboreal type. The gorilla represents an extremely interesting experiment, as it is ill adapted structurally for arboreal existence and of all the anthropoid types most closely approaches man in terrestrialness and in locomotor habits.

Intimately related to arborealness and perhaps definitely correlated with it, are agility and the time-relations of activities. It appears that arborealness, agility, and quickness of response are directly related and that with adaptation to and assumption of terrestrial existence the primate becomes slower, more deliberate, and also markedly less agile. With reasonable assurance we suggest as order of increasing agility: gorilla, orang-outan, chimpanzee, siamang, gibbon. That this is also the order of increasing quickness of response, and of lessening time of neuromuscular processes, is probable. These considerations are of peculiar importance to the neurologist and psychologist, because they suggest important natural experiments in primate adaptation and evolution.

In evolutional discussions of the primates much attention is given to manner of walking, since it is assumed that the erect posture and accompanying ability to walk bipedally indicate relation to man. If this be true, gibbon and siamang might be ranked nearer to man than the great apes. Although it is possible on occasion for any one of the anthropoid types to stand erect and to walk for a short distance bipedally, this is achieved most naturally and successfully by gibbon and siamang. Placing the feet flat upon the ground and using the raised arms as balancing organs, these creatures freely walk, waddle, or hop along when they abandon tree for ground. That they walk erect and bipedally naturally instead of as result of imitation or tuition is far from equivalent to the assertion that they do so easily and skilfully. On the contrary the process is obviously difficult and fatiguing, and locomotion is awkward and relatively slow. Neither gibbon nor siamang voluntarily takes to the ground when it can

achieve its objective by progression through trees.

For the great apes the order of increasing ease, skill, and efficiency in bipedal walking is: orang-outan, chimpanzee, gorilla. Any one of them on occasion may stand erect and walk a short distance, but as in the case of the Hylobatidae this is done with difficulty, and it obviously is an unnatural and inefficient mode of progression. When standing erect the orang-outan rests its weight on the outer edges of the feet instead of placing them flat on the ground. This position strikes one as extremely awkward, and suggests that the foot is held in such manner as to facilitate grasping objects. Both chimpanzee and gorilla when they stand erect ordinarily place the feet flat on the ground, but there are individual, if not also species, differences in the distribution of weight, since tendency often is observed to rest rather on the outer edge than squarely. Either chimpanzee or gorilla may walk a considerable distance standing perfectly erect and using the arms occasionally to assist in maintaining or regaining balance. It is our opinion that the order of increasing naturalness and frequency of erect attitude and bipedal locomotion in the anthropoid types, namely, orang-outan, chimpanzee, gorilla, siamang, gibbon, is misleading and that instead of indicating, as might first be assumed, degree of relationship to the human posture and manner of walking, it represents behavioral adaptation to structural peculiarities. The gibbon, because of proportions of limbs and body and characteristics of extremities, when compelled to take to the earth walks more naturally and readily bipedally than quadrupedally, whereas the reverse is true of the more nearly terrestrial gorilla.

When on the ground, orang-outan, chimpanzee, and gorilla naturally walk quadrupedally. In each the weight of the body rests chiefly on the feet, while the closed hands are applied so that such weight as comes upon them rests on the knuckles and outer surface of the fingers. We have discovered no description of either gibbon or siamang walking in this manner. Orang-outan, chimpanzee, gorilla is the order of increasing naturalness and skill in this mode of progression. The orang-outan seldom rests its feet squarely on the earth, but instead, as previously stated, places the weight on the outside of the foot, in what seems an extremely awkward and fatiguing position. This is not true of the chimpanzee, for it walks with evident ease and skill and runs quadrupedally much faster than can the gorilla. Rate of arboreal locomotion increases in the order: gorilla, orang-outan, chimpanzee, siamang, gibbon; whereas that of terrestrial bipedal or quadrupedal locomotion increases in the order: siamang, gibbon, orang-outan, gorilla, chimpanzee.

Expertness, facility, and skill in climbing increase in the order: gorilla, chimpanzee and orang-outan, siamang, gibbon. This, as it happens, is identical with our proposed order of increasing arborealness. Of the five types which we are comparing, gibbon and siamang are most expert and skilful in climbing. With great speed, surety, and grace they swing from branch to branch and tree to tree, using the arms as organs of propulsion and flying through the air with the legs drawn close to the body. Feet as well as hands may be used to grasp with, but swinging as contrasted with jumping is the natural mode of arboreal progression. These statements apply only to the Hylobatidae, for the three great apes climb in more nearly human fashion, using hands and feet as grasping organs and arms and legs for propulsion.

Usually the orang-outan moves through the trees cautiously, although, considering its weight, with surprising rapidity. It rarely jumps, and although it may on occasion swing by its arms, it apparently prefers to use all of its extremities in grasping supporting structures. The chimpanzee appears to be somewhat more agile and venturesome in climbing, but its method is essentially the same as that of the orang-outan. Often it rushes from branch to

branch and swings or leaps through the forest. If gibbon and siamang constitute a preëminently gifted group of anthropoid climbers, certainly chimpanzee and orang-outan rank second, and gorilla is in a class by itself since it climbs scarcely better than an agile, acrobatically inclined boy. This apparently is due quite as much to the structural characteristics of hands, feet, arms, and legs as to differences in bulk and weight. Impressive is the contrast between gibbon and gorilla. The former is almost birdlike in its arboreal locomotion, while the latter moves slowly, laboriously, and with care to test supporting structures and to retain hold of them with hands and feet.

That any of the anthropoid types naturally take to the water is not established. Instead, available information suggests that, like man, the types of primate which we are considering fear and avoid deep water. For gibbon and siamang we have discovered no evidence of ability to swim either naturally or as result of enforced practice. Experimental tests seem to indicate, although they do not conclusively prove, that neither orang-outan nor chimpanzee when young is capable of swimming, and although comparable observations for gorilla are lacking such evidence as we have discovered is negative. Observations concerning distribution and geographical relations of varieties and races suggest that large rivers may constitute migrational barriers for orang-outan and chimpanzee and possibly also, although this is less clear, for gorilla. Almost certainly if any one of these types of primate really liked the water and swam naturally with assurance and facility, the behavior would have been observed by natives, hunters, and naturalists and the literature would present definite descriptions. Actually all that we have discovered is indefinite and, in the main, negative evidence; therefore the tentative conclusion that no one of the anthropoid types swims naturally and skilfully.

Descriptions of dance movements and other rhythmic activities are lacking for gibbon and siamang, and also, except as it is influenced by association with man, for orang-outan. The chimpanzee and gorilla, however, are known to indulge in crude dances and in rhythmic pounding of the ground or of such sound-producing objects as hollow trees. The tendency to rhythmic action and enjoyment of dance movements is most often noted in the chimpanzee, whereas in the gorilla delight in rhythmic pounding or beating of self or other objects is correspondingly conspicuous.

Manual contrasts. The behavioral tendencies suggested by the terms handedness, footedness, and eyedness have been discovered in those anthropoid types which have been carefully studied. There is ample ground for the assumption that for morphological or functional reasons preferential use of one hand, one leg and foot, or one eye frequently appears. That all or any one of the anthropoid types is definitely right-handed or left-handed or that an individual of any type is uniformly and consistently right-handed or left-handed has not been established observationally. Still less is there evidence in support of the assertion that type or individual is consistently right- or left-footed and right- or left-eyed. Several writers have reported convincing indications of preference for the one hand, foot, eye, or the other in a particular activity or behavioral pattern.

In addition to the pounding of self and other objects, there is manifested by one or another of the anthropoid types tendency to use the hands for manipulating objects. The orang-outan, chimpanzee, and gorilla are known on occasion, if not regularly, to throw objects, often with apparent defensive or destructive intent. Comparable behavior has not been reported for gibbon and siamang. Among the five anthropoid types there exist marked differences in degree of manual skill or dexterity and in the variety of ways in which the hands and feet are used. In the light of rather scanty observational data we present as order of increasing manual skill, dexterity, and versatility: siamang, gibbon, gorilla, orang-outan, chimpanzee. We are extremely doubtful

about the order of the last three; possibly it should instead be: orang-outan, gorilla, chimpanzee.

Nest construction and sleep. These, it appears, are perennially interesting subjects for hunter and naturalist. Consequently information is abundant and relatively satisfactory. The gibbon and siamang do not construct nests or shelters of any sort for protection from storm or as beds. It is said that in nature they usually sleep upright, or in a reclining posture, in the crotch of a tree, or in such other position as permits them to grasp limbs or twigs with hands and feet to safeguard themselves against falling. Meager indeed are the descriptions of the resting and sleeping habits of the Hylobatidae. Eventually it may be established that under some circumstances they construct crude nests. In captivity they often sleep lying on the ground.

By contrast with the gibbons and siamang, each type of great ape is known to construct nests as sleeping places and for the shelter and protection of female and young. The orang-outan always places its nest in trees. The construction is crude, but it serves as a secure resting place. Likewise the chimpanzee regularly builds its nest or bed in trees. Neither it nor the orang-outan ordinarily constructs any covering for protection from storm. There are some indications that the nest of the chimpanzee is more skilfully built and at times more elaborate than that of the orang-outan. Apparently, of all the anthropoid types, the gorilla alone constructs both ground and tree or bush nests. In all probability the adult males commonly build on the ground while immature individuals and females with young more frequently locate the structures in bushes or in trees at no considerable distance from the ground.

In sleep, orang-outan, chimpanzee, and gorilla, like man, lie on back or side. Often the head rests on one or both arms as on a pillow. Snoring during sleep has been reported for the orang-outan and gorilla. In all probability it occurs also in the chimpanzee. The suggested order of increasing resemblance to man in skill and elaborateness of nest construction, sleeping posture, and activity during sleep is: Hylobatidae, orang-outan, gorilla, chimpanzee.

Eating and drinking. All of the types are primarily vegetarian, but differences appear in degree of adaptiveness to foods and in preference for vegetable products. Contradictory statements abound because of differences in dietary preferences and nutritional requirements between free and captive individuals. It is now well known that captivity may essentially alter the digestive activities and correspondingly the nutritional needs of the organism. Further, a captive ape may be taught to take foods which in nature it would reject. Thus it happens that one or another of the anthropoid types is frequently said to be carnivorous or omnivorous instead of vegetarian, herbivorous, or frugivorous.

The facts apparently are that gibbon and siamang are vegetable feeders of high degree of adaptability, which take in nature, as opportunity offers, such animal products as eggs, insects and other small animals. In captivity they are relatively easy to feed if in health and contented. Similarly the orang-outan is a vegetable feeder. The extent to which it naturally accepts animal products is uncertain, but many demonstrations have shown that it can be taught to accept the human diet and may thrive on it. Like the Hylobatidae, it is relatively adaptable and not especially difficult to feed in captivity. Although naturally a vegetarian the chimpanzee in captivity may be accustomed to a meat diet. Some observers have gone so far as to assert that this is both natural and necessary. The indications instead are that in nature it commonly supplements its plant diet by capturing small animals and robbing the nests of birds. The gorilla as vegetarian exhibits local differences in that the highland type is primarily herbivorous, whereas the lowland form is more largely frugivorous. All of the anthropoids are careless eaters which in their haste to satisfy their appetite destroy and waste more than they devour. The gorilla

is relatively unadaptable and of all the types most difficult to feed when captive. The reasons, although perhaps primarily nutritional, are almost certainly to a considerable degree psychobiological.

Water is taken freely by all of the anthropoids, in characteristic ways. Thus the gibbon and siamang commonly obtain their supply by licking or sucking it from the hand and arm on which it accumulates as the animal passes through the wet vegetation. Occasionally in nature, and frequently in captivity, they drink directly by dipping the hand and sucking the water from it, or even by placing the lips to the water. Somewhat more varied are the drinking habits of the orang-outan, for in addition to sucking or licking the liquid from hand or arm as do the Hylobatidae, this great ape may extend its lower lip and catch the water as it falls from the clouds, protrude its lips funnel-like and applying them to the surface of the water suck it up, or, and especially in captivity, it may apply its lips directly to the surface of the water or to a vessel which it holds in its hands and drink in almost human fashion. So far as we have discovered the chimpanzee does not suck or lap the water from arm or hand as do the gibbon, siamang, and orang-outan. Instead it seemingly prefers direct application of the lips to the liquid. We suspect, however, that this description is incomplete and that circumstances determine the behavior. Our description indicates merely what appears to be the preferred mode of drinking. Finally, in the gorilla the preference is very definitely for the direct use of the lips, which are applied to the surface of the water or, in captivity, to the edge of the container. Clearly enough the order of increasing similarity to the human mode of drinking is: gibbon and siamang, orang-outan, chimpanzee, gorilla.

Response to captivity. The various anthropoid types are extremely difficult to capture and to accustom to captivity after they have attained maturity. The young may be obtained with ease, depending upon the abundance of the animals and the nature of their habitat, by shooting the nursing mother and frightening away other adults. This indeed is the inhumane but prevalent method. A widespread superstition characterizes gibbon and gorilla as peculiarly difficult to accustom to captivity and to maintain in health and contentment. By contrast, orang-outan and chimpanzee are considered favorable risks. Abundant and varied information suggests as order of increasing adaptiveness to captivity and ease of maintenance: gibbon, siamang, gorilla, orang-outan, chimpanzee.

Although all of the types are extremely difficult to tame when captured as adults, the young promptly recognize kindness and quickly become attached to friendly human attendants. Undoubtedly there are important generic differences in rate and degree of tamability. The revelations of the literature and our own experience suggest as order of increase for specimens in childhood: gorilla, siamang, gibbon, orang-outan, chimpanzee.

No one of the types is strictly domesticable, for although individuals become thoroughly accustomed to life in captivity and may even appear contented with it, they never become reconciled to monotonous labor or to human service otherwise than as actors. Despite numerous misleading statements based often upon observation of diseased or otherwise abnormal specimens, all of the anthropoid types are naturally cleanly in their habits and under normally favorable circumstances maintain body and surroundings in hygienic condition. That they are as resistant to disease and as capable of recovery from injury as is man or any other primate, if not definitely indicated by reliable observations, at least is not contraindicated. This we assert in the face of numerous accounts of the delicacy of gibbon, gorilla, and orang-outan, and the common belief that it is almost impossible to maintain siamang, gibbon, or gorilla captive in the United States for any considerable period.

SOCIAL TRAITS

The anthropoid types differ markedly in social characteristics and relations. Comparison may profitably be made with respect to gregariousness, dominance or leadership, sociability or social dependence, playfulness, and nomadic or migrational tendency.

Gregariousness and dominance. Of all the types the orang-outan alone is described as solitary. Reasonably adequate information determines the order of increasing gregariousness as: orang-outan, chimpanzee, gorilla, gibbon and siamang. Although the orang-outan may tend to solitariness and also toward segregation of the sexes, immature individuals commonly gather and stay together. All of the other types live either as families or bands. The social unit for gibbon and siamang is the band or herd. Whether or not this is constituted of permanently mated pairs and of families is not known. Presumably the orang-outan social unit is the mated pair, for there appears to be no other constantly recurring and predictable social grouping. Without doubt immature individuals of both sexes, and females with dependent young, often associate temporarily, but these aggregations evidently are not comparable in constancy and stability with the Hylobatidian band. For the chimpanzee the unit is undoubtedly the family, although associated families may constitute more or less stable bands. Likewise the social unit in gorilla life is the family, and it is definitely indicated that, as in the chimpanzee, several families may associate and thus constitute a band or herd. Anthropoid social units vary in size from the mated couple to bands of ten to twenty chimpanzees, twenty to thirty gorillas, at least in the mountain species, and thirty to fifty gibbons or siamangs. Segregation of the sexes, so far as known at present, occurs frequently only in the orang-outan.

Dominance and leadership characterize each of the types. Little is known about this relationship in gibbon and siamang, but it is asserted that the bands are led. Among orang-outans the male is dominant, but leadership is little in evidence because of the lack of permanent social grouping. The male chimpanzee is dominant in family and band, and in the latter aggregation a mature male acts as leader. This is true also of the gorilla, for whether the social group be family or band, a mature, and often gray-backed, male is in command and leads as well as dominates the group. Unless it be among gibbons and siamangs, equality of influence and opportunity does not manifest itself in the social life of the anthropoid apes.

Sociability and mutual dependence. Here also radical differences exist. Undoubtedly the traits are intimately related to gregariousness and dominance. Definitely indicated as order of increasing sociability and presumably also of dependence on companionship is: orang-outan, gorilla, chimpanzee, siamang and gibbon. Between the last two we are unable to distinguish; possibly the order should be reversed. But in case of the great apes the differences are extreme. It may be doubted whether the gorilla is distinctly more sociable and dependent than the orang-outan; we are convinced by available records and by our own experience that it is. In any event the chimpanzee is highly sociable and socially dependent as compared with either orang-outan or gorilla. No one of the anthropoid types ordinarily may be maintained healthful and contented in captivity without species or other companionship.

Playfulness and social resourcefulness. Conspicuous, often, during the early life of the anthropoid, these characteristics steadily, and as a rule rapidly, diminish after maturity is achieved. It will be assumed that playfulness implies a measure of inventiveness, originality, and individual variability in activity and as well certain versatility in social adjustment. The order of increase for the types is: siamang and gibbon, orang-outan, gorilla, chimpanzee. In our own experience the chimpanzee is by far the most highly gifted of the anthropoids in playfulness and social resourcefulness, while by contrast the orang-outan

ranks low. We are unable to make safe comparison as among siamang, gibbon, and orang-outan, but undoubtedly the last presents considerably greater diversity of playful activity and also a larger measure of social resourcefulness than do the Hylobatidae.

Nomadism and migration. All of the types are nomadic, for as vegetarians they are forced to follow the supply of food and to move from place to place in accordance therewith. But even apart from this requirement it is a justifiable inference that they would wander or rove about instead of living as does man in an established habitation and location. Gibbons and siamang are said to wander daily for considerable distances through the treetops in their search for food. If their feeding ground happens to be on plateau or mountain they habitually return to the warmer valleys for the night. It is asserted that the orang-outan also moves from place to place, but the expression "wandering in search of food or suitable nesting place" appears to be more appropriate than "migration." Both chimpanzee and gorilla are pronouncedly nomadic. Seldom, it seems, do they continue in any one spot for more than a few days and usually they change nesting or sleeping places almost daily. Whereas nomadic habit is unquestionable, migratory tendency is not satisfactorily established for any one of the types. It is indicated that the animals may respond to seasonal or other climatic influences affecting food supply, but movements ordinarily are not extensive and until additional information is provided it may not safely be asserted that the anthropoid types, or indeed any of them, periodically migrate.

LIFE HISTORY

Data relative to courtship, mating, marital and family relationships; menstruation, gestation, parturition; rate of growth, age at maturity, and span of life, are too few and difficult of evaluation to justify dogmatic statements about likenesses or differences. What we are about to present should be considered as tentative, since for no type or individual is complete account of life history available.

Courtship and mating. Tendency to personal adornment or decoration during adolescence and early maturity has been observed in orang-outan, chimpanzee, and gorilla; never, so far as we know, in gibbon and siamang. This difference probably is attributable to lack of suitable observational opportunity. There are no satisfactory descriptions of courtship. Sexually significant dance movements are known to occur in chimpanzee and gorilla, and presumably they appear also in orang-outan. It is not conclusively established that matings are seasonal, but the facts available suggest that there is a definite breeding season, or possibly seasons, for each of the five types. That mated male and female continue together between breeding seasons, or that matings are relatively permanent, may not be asserted. As order of increasing probability of permanency of association of male with one or more females we suggest: gibbon and siamang, orang-outan, chimpanzee, gorilla. There are definite indications of monogamy in the chimpanzee, whereas in the gorilla polygamy almost certainly occurs. Concerning gibbon and siamang there is no basis whatever for statement.

Our tentative inference is that both monogamy and polygamy exist in one or another or all of the anthropoid types and that in all probability both relationships are discoverable in each of the manlike apes. With many misgivings we propose as order of increasing probability of monogamic relation: gibbon and siamang, gorilla, orang-outan, chimpanzee. Much more systematic, thorough, and critical investigation than has heretofore been conducted will be essential to discover the truth. Indicated as points of contrast among the three types of great ape are temporary monogamous or polygamous relations in the orang-outan, relatively permanent monogamous and possibly also polygamous relations in the chimpanzee, and in the gorilla a patriarchal family, with polygamy presumably in the

mountain species and monogamy, possibly, in the lowland species.

Female reproductive activities. The occurrence of catamenia or menstruation in the anthropoid apes has been established. Reliability and adequacy of observation vary greatly for the types. On basis which appears to us inadequate it is asserted that the cycle is approximately lunar in gibbons. In orang-outan and chimpanzee the period is known to be approximately one month. There are observations which are thought to indicate monthly menstruation in the gorilla, but to us they appear inconclusive. If, however, the phenomenon occurs in orang-outan and chimpanzee it presumably occurs similarly in gorilla.

The period of gestation has not been decisively determined for any one of the types. Under usual conditions of observation difficulties have proved insuperable. It is known that at least in certain types menstruation does not necessarily cease with conception; hence failure of catamenial activity may or may not mark the beginning of gestation. The best data available suggest for gibbon and siamang gestational period of seven months; for orang-outan and chimpanzee, nine months; for gorilla there are no observations which justify estimate. Indeed, the whole subject is in such unsatisfactory status that it may presently appear that no one of the estimates which we have presented is correct. Probably it is entirely safe to predict that in gibbon and siamang the period is not less than five nor more than seven months, and in orang-outan, chimpanzee, and gorilla not less than seven nor more than nine.

Although doubtless parturition has been observed in captive specimens of one or another of the anthropoid types, the only description of the phenomenon which we have discovered is that of Fox for the chimpanzee (pp. 255-256).

Growth, development, longevity. The weight of the newborn anthropoid is undetermined. Even guesses are lacking in the case of gibbon and siamang, while for the great apes guesses, estimates, and relatively unsatisfactory direct observations range from three to seven pounds. Certain well-informed authorities deem it probable that weight at birth is much less in orang-outan, chimpanzee, and gorilla than in man and that growth immediately subsequent thereto is much more rapid. They tentatively assume that three pounds is a reasonable estimate. We are not wholly convinced by their arguments and venture to interpret available materials as suggesting instead weight of three to seven pounds.

There are no reliable anthropometric observations for the anthropoid types during infancy. The assertion that growth is more rapid than in man is inadequately supported. Statements indicate that whatever the rate of body growth in gibbon and siamang, sexual differentiation and the development of the teeth occur relatively slowly and late. Because of the retarded sexual differentiation, determination of sex in immature specimens of gibbon has proved difficult for the inexperienced morphologist and mistakes have frequently occurred. It is entirely possible, although we cannot consider it probable, that growth and development are slower in gorilla than in orang-outan and chimpanzee.

At what age sexual maturity is achieved is uncertain. Observational indications and estimates range from seven to twelve years. The suggested order of increasing age or prolongation of infancy and youth is: gibbon and siamang, orang-outan and chimpanzee, gorilla. Our evaluation of available data leads us to suggest the following as indicative of contrast in rate of maturation and of range in age: for gibbon and siamang, five to eight years; for orang-outan and chimpanzee, eight to twelve years; for gorilla, ten to fourteen years. It is commonly assumed that the female anthropoid ape, as the female of our own genus, matures sexually somewhat more rapidly and at an earlier age than does the male. We have not discovered observational justification for the assumption.

There are indications that growth continues for some time after sexual maturity;

for how long is uncertain, as are also differences among anthropoid types. The evidences are wholly convincing that at fifteen to eighteen years of age the great apes are wholly mature and fully grown. At what age senility begins to manifest itself has not been ascertained. Certain observations suggest that orang-outan, chimpanzee, and gorilla between fifteen and twenty-five years are in their prime. Average duration of life is unknown, but guesses and estimates concerning longevity are not lacking. It is said that gibbons and siamangs may live twenty to thirty years; orang-outans, chimpanzees, and gorillas, forty, fifty, or even sixty years. Of direct and reliable observations there are none, and there are no other grounds of estimate than the morphological. It is not unreasonable to assume that, under favorable conditions, any one of the great apes might live as long as does man.

AFFECTIVE TRAITS

No assemblage of psychobiological characteristics is more difficult to describe briefly and safely than the affective. Language proves inadequate for description of conditions and indication of contrasts. Nevertheless, attempt is made in this section to characterize briefly the affective life of each type and to make comparisons.

Emotionality and expressivity. As observers of organic behavior we gauge emotionality by its behavioral expressions. Possibly this is an indefensible procedure, for in all probability the organic type or individual which lacks, inhibits, or represses behavioral expression is quite as emotional as that in which expression is conspicuous. If despite this risk or error, we permit expressivity to determine order of increasing emotionality we obtain the series: gorilla, orang-outan, gibbon and siamang, chimpanzee. Assuredly gorilla is the least expressive of all; that it is least emotional we do not presume to infer. Orang-outan also is relatively inexpressive, whereas chimpanzees promptly impress even the inexperienced observer with the richness of their emotional life and their ability to express it.

Dispositional contrasts. Since disposition varies extremely with age, sex, and physiological status, and since further no one of the anthropoid types is adequately known in maturity, it is indeed risky to indulge in single-word descriptions. We assume the risk only because we have previously safeguarded ourselves by offering numerous case studies and detailed descriptions. Briefly, then, the gibbon is commonly described as shy, timid, gentle, good-tempered, quick in emotional response, affectionate, appreciative of considerate and kindly treatment. The siamang contrasts with the gibbon no less markedly in disposition or temperament than in physique. It is said to be slower, less gentle, more bold, less friendly and good-tempered, somewhat awkward and apathetic. We are far from convinced that the characterization is reliable or adequate. Certainly the literature does not afford a satisfactory picture of the type.

The orang-outan, quiet, inactive, or sluggish, gives the impression of stolidity, brooding, depression, melancholy. It is phlegmatic and its attitude and behavior often strikingly suggest pensiveness and pessimism. Strong indeed is the contrast between this picture and that of the chimpanzee, for it is active, lively, sanguine, very highly expressive, with indications of nervous instability, restlessness, impulsiveness. The gorilla, although differing markedly from both, seems to be more like the orang-outan than the chimpanzee temperamentally. It is shy, retiring, discreet, deliberate rather than stolid, obviously self-dependent and self-centered. Elsewhere (p. 456) we have thus contrasted the immature chimpanzee and gorilla. The former is gay, sparkling, sportive, cheerful, optimistic; the latter, quiet, serious, phlegmatic, self-centered.

Differences in the time-relations of psychoneurological processes are exhibited by affective behavior. For whereas gibbon and chimpanzee, the quickest reactors among

the anthropoid types, exhibit almost kaleidoscopic affective changes, orang-outan and gorilla, relatively slow reactors, are slow also in emotional change and transition. The contrast may be still better expressed in terms of mood, for whereas the quick types are not obviously moody, the slow types are. The order of increasing tendency to expression of mood or moodiness is: gibbon and siamang, chimpanzee, orang-outan, gorilla.

Variety of emotional pattern. Each of the principal categories of human emotion may be recognized in the anthropoid types, but recognition and description are easier in the great apes than in the Hylobatidae. Timidity, fear, terror, although manifested by all of the types, increase in frequency, strength, and variety of expression in the order: gorilla, orang-outan, chimpanzee, gibbon and siamang. This of course is not necessarily the correct order of increasing shyness, but instead that of manifestation or expressiveness. Resentment, anger, rage are universal, but the extent to which they gain expression varies greatly. The gorilla, especially in captivity, commonly inhibits response, whereas the chimpanzee violently expresses itself. Therefore the order of increasing expression: gorilla, orang-outan, gibbon and siamang, chimpanzee. In each of the types except gorilla that emotional outburst, which in the child is known as temper tantrum, has been observed. It is, we believe, peculiarly significant that it is lacking or infrequent in gorilla. Agreeable emotions—pleasure, contentment, satisfaction—with smiling, laughter, indications of humor, and mischievousness, may be observed in any of the types, but with increasing definiteness and frequency in the order: gorilla, orang-outan, siamang and gibbon, chimpanzee. Evidences of sorrow, grief, depression, sympathy, attachment, mutual and altruistic aid are few in the case of gibbon and siamang, but increasingly abundant and trustworthy in the order: orang-outan, gorilla, chimpanzee.

Vocalization and sound production. Conspicuous among modes of emotional expression is sound production. Each of the anthropoid types possesses vocal mechanism similar to the human, but it is used in sharply contrasted ways and in very different degrees. The order of increasing frequency of vocal expression in the five types appears to be: gorilla, orang-outan, chimpanzee, siamang, and gibbon. Both gorilla and orang-outan are referred to commonly as silent or taciturn, whereas the Hylobatidae and chimpanzee are notoriously noisy.

Sound production, however, is not limited to vocalization. Certain apes use the hands either instead of or to supplement the vocal mechanism. In order of increasing frequency and variety of nonvocal sounds the types arrange themselves: gibbon and siamang, orang-outan, chimpanzee, gorilla. For gibbon, siamang, and orang-outan records of nonvocal sound production are rare, whereas for chimpanzee and gorilla they are abundant. Both hands and feet may on occasion be used by the chimpanzee to beat on the earth or on surrounding objects. That this is done in order to make a noise is highly probable. The gorilla, most taciturn perhaps of all the types, leads in nonvocal sound production, for it uses either clenched or open hands to beat upon its own body or on other objects and thus produces a considerable variety of sounds. Among the observed modes are rhythmic beating of chest with clenched fists; rhythmic beating of cheeks with the palms, the mouth being held open; rhythmic striking of open lower jaw with the hands, thus producing a rattling noise by contacts of the teeth; rhythmic pounding on the ground, on hollow logs, hollow trees, and other objects which when struck give forth sounds. While the chimpanzee appears to be a most gifted vocalist among anthropoid types, the gorilla evidently is correspondingly gifted in production of nonvocal sounds. These statements of course must not be taken to imply that the various apes do not on occasion use their voices vigorously and to good effect. Notable instances are conditions which arouse fear, anger, or suffering.

Speech and other means of intercommuni-

cation. The calls and cries of gibbon and siamang are definite, specific, relatively simple and not markedly varied or variable. By contrast the vocalizations of the great apes much more strongly suggest approach to linguistic expression. In the adult orang-outan may be observed such sounds as grunts, squeaks, screams, roars, and in the young whimpering, crying, murmuring. Still more varied and more frequently occurring are the vocalizations of the chimpanzee. It is impossible to describe them adequately or to enumerate them in this brief summary. It must suffice to characterize many of them as approaching the form and affective function of the human vocal symbol.

It may not be asserted that any one of the anthropoid types speaks. The gibbon is said to possess only a pseudo-language. Following the same line of thought it may be maintained that the order of increasing approach to systematic use of the voice as means of expressing feelings, desires, and ideas, is: gibbon and siamang, gorilla, orang-outan, chimpanzee. Intercommunication, although in a measure dependent upon vocalization, is conditioned also by many other processes. Conspicuous among them are bodily attitude, facial expression, gesture, and other meaningful acts. Mutual understanding and transfer of experience among apes are dependent rather on vision than on hearing, for the animal reads the mind of its fellow, interprets attitude, and foresees action rather as does the human deaf-mute than as the normal person who listens and responds to linguistic vocalization. Intercommunicational complexity and biological value increase, we hazard, in the order: gibbon and siamang, orang-outan, gorilla, chimpanzee.

Motivation. Activity is motivated and conditioned by psychobiological processes which, according to observational indications, become increasingly numerous and complex with the ontogenetic and phylogenetic development of the nervous system. Such notable differences in the motivation of the anthropoid types are indicated by experimental studies that we feel justified in presenting tentatively as order of increasing variety and complexity of motivational factors: gibbon and siamang, orang-outan, chimpanzee, gorilla.

RECEPTIVITY—THE SENSES

Morphological considerations. The psychobiological phenomena of receptivity are either processes occurring in central or peripheral nervous system or bodily changes intimately related to them. Consequently it is pertinent to compare the nervous system in anthropoid types. Gibbon and siamang, orang-outan, chimpanzee and gorilla, this order is presumably the correct one for increasing resemblance of the anthropoid brain to that of man. Use of the connective "and" indicates uncertainty about the proper order for gibbon and siamang and for chimpanzee and gorilla. Generally neurologists assert that the brain of gorilla in configuration, proportions, and other aspects of gross structure, most closely resembles that of man. There are, however, some respects in which the brain of the chimpanzee takes first place and it has not been established that in finer structure and the nature and relations of functional processes the gorilla nervous system is either superior to that of the chimpanzee or more similar to the human.

The peripheral nervous system, including receptors or sense organs, nerves, and ganglia, although generally and in most instances intimately known in each of the anthropoid types, has not been so fully and accurately described that useful comparisons are possible. Highly developed organs of special sense exist not only in the anthropoid types but in all other primates. Significant structural differences of eye, ear, or other type of receptor have not been exhibited and it is only on the basis of analogy and by inference from facts of behavior that comparison in receptive equipment can be made. It is commonly assumed, nevertheless, that the order indicated above for increasing resemblance of the brain to that of man is also the order of increasing complexity of development in the peripheral

nervous system. Possibly there may be other, or more numerous, types of receptor in orang-outan, chimpanzee, or gorilla than in gibbon or siamang. To us it appears extremely improbable. Possibly, or even probably, certain of the receptors of the great apes are more highly developed than are those of the Hylobatidae.

Modes of receptivity and sensibility. No human mode of stimulus reception or variety of sensibility is definitely known to be lacking in the anthropoid apes. Only the so-called special senses—sight, hearing, touch, taste, smell—are even mentioned in the scientific literature, and of these only the sense of sight has been carefully studied and that in but a few of its important aspects. Comparison of types is impossible even with respect to the number and variety of modes of receptivity, and observational basis is entirely lacking for fruitful comparisons within a given mode of reception or sense. It is difficult to understand this dearth of knowledge, since anthropoids have long been available to the neurologist and psychologist. Whatever may be the reasons for neglect, the extraordinary importance of research is obvious, and likewise the excellent opportunity for comparative study of anthropoid and human nervous system and functions by correlated morphological, physiological, and psychological inquiry.

Photo-reception and eyesight. Vision unquestionably is a highly developed sense in all of the anthropoids. Monocular, binocular, stereoscopic, achromatic, and chromatic vision have been demonstrated in the chimpanzee; the other types have not been observed. It is indicated that for the chimpanzee at least, vision in many respects is essentially like that of man. That vision or any other sense is more complex or more highly developed in gorilla, chimpanzee, or orang-outan than in gibbon or siamang is not established by reliable observation and report. Therefore comparison of types is impossible and if we should suggest that the order of increasing complexity and diversity of visual function and experience is: gibbon, siamang, orang-outan, chimpanzee, gorilla, it would be chiefly surmise. When, however, perceptual processes are associated with the sensory, basis for comparison is markedly improved and justification appears for the order: gibbon and siamang, orang-outan, gorilla, chimpanzee.

INTELLIGENCE: BEHAVIORAL ADAPTIVITY

There is no lack of materials for comparison in this case, but oftener than not they are unreliable, incomplete, or otherwise unsatisfactory and difficult to evaluate. At considerable length in earlier chapters we have presented descriptions of adaptive and intelligent behavior. There follow comparisons with respect to a few of the many forms and aspects of behavioral adjustment. Those have been selected for remark which appear to be at once important and observationally established.

Curiosity. Impelling the organism to investigation, and ultimately to systematized research, is curiosity or inquisitiveness. It appears to be an important condition of progress in the primates and through diverse activities which are commonly designated as fooling, aping, imitating, it leads undoubtedly to invaluable acquaintance with physical and social environment and prepares the way for behavioral adaptation. Often it tends to express itself in destructiveness, but even so it may be profitable to the organism. It is known that in degree of development and diversity of expression curiosity differs greatly among the primates and it appears that for the anthropoid types the order of increasing functional significance is: siamang and gibbon, orang-outan and gorilla, chimpanzee. We have linked siamang and gibbon, also orang-outan and gorilla, because uncertain of the proper order. Unquestionably there is pronounced difference in the psychobiological rôle of curiosity as between Hylobatidae and great apes.

Imitation. Also an important condition of adaptation is the tendency to imitate what is seen or heard. Several kinds of imitation are distinguished. They vary in complexity

and in the nature of the psychoneural processes which are involved. Although certain primates are notoriously imitative, complex forms of imitative behavior, with definite, purposeful repetition of acts to secure an objective, have been both denied and affirmed in case of the anthropoid apes. On the whole the evidence for the great apes is positive and as order of increasing complexity, frequency, and functional significance of imitative behavior, we present: gibbon and siamang, gorilla, orang-outan, chimpanzee. For the Hylobatidae the order is uncertain because of inadequate information. For gorilla interspecies imitation has seldom been observed and the type is ranked below orang-outan and chimpanzee because it appears to be distinctly less imitative of man and other organisms than are the other great apes.

Presumably histrionic ability, with its expressions in behavioral mimicry and acting, is intimately related to imitation. It appears in all of the anthropoid types but most conspicuously in the chimpanzee, which is by far the most easily trained as a performing animal and histrionically the most gifted. All of the anthropoid types are gifted acrobatically, but the chimpanzee, in addition, is by nature an actor. Gibbon, siamang, and gorilla, are very rarely used as stage performers, orang-outan occasionally, and chimpanzee commonly. This, in addition to numerous naturalistic and experimental evidences, determines as order of increasing ability: siamang and gibbon, gorilla, orang-outan, chimpanzee.

Tuition. Yet a third highly significant condition of behavioral adaptation and aid to it is social tuition or instruction. With degree of importance which apparently increases from lower to higher types of primate, it supplements imitative tendency. Parental instruction in walking has been observed in the great apes, but no records have been discovered for gibbon or siamang. The scanty data available justify as tentative order of increasing importance of tuition: gibbon and siamang, gorilla and orang-outan, chimpanzee. This order apparently holds for human instruction as well as for intraspecies tuition. It is, for example, very much easier to teach the chimpanzee than the gorilla, and in general easier to teach one of the great apes than either gibbon or siamang.

The generalization particularly worthy of emphasis in this summary is that curiosity, imitativeness, and amenability to tuition or instruction are, on the whole, more highly developed and more important as conditions of behavioral adaptation in the anthropoid types than in any other infrahuman organism, and, further, that they tend to become increasingly significant in the order: Hylobatidae, gorilla and orang-outan, chimpanzee.

Attention. Absolutely essential as aspect of many forms of behavioral adaptivity is attention. It is readily observable in the anthropoid apes; so also are variations in concentration and span. The lower the degree of attentional concentration and the shorter the span or more rapid the fluctuation, the less efficient is primate adaptation to highly exacting and novel environmental situations. The probable order of increasing concentration and span of attention for the anthropoid types is: gibbon and siamang, orang-outan, chimpanzee, gorilla. All types of great ape are capable of definitely directed, highly concentrated, and sustained attention.

Modes of adaptation. There are several distinguishable varieties, forms, or types of behavioral adjustment. They are often referred to as forms or modes of learning. It is not now in order to enumerate them, but instead it appears desirable to select for comparative statement those types which appear to be characteristic of, if not also limited to, the anthropoid apes and man. Adaptation by process of "trial and error" is characteristic of the mammalia, but in the anthropoid types it is most importantly supplemented by two forms which we have designated as adaptation with insight and adaptation with foresight.

Ability has been demonstrated in certain organisms to perceive relations among sen-

sory elements, objects, or perceptual configurations, and to respond to relation instead of to a particular sensory element, object, or configuration. For example, the chimpanzee, having been trained to select always from two otherwise similar boxes the one which is the larger, in order to obtain food, is capable of choosing correctly even when the box which was previously the larger is made the smaller member of a pair. In this case adaptation rests upon perception of relative size, and the organism instead of choosing a particular object chooses the one which is the larger. This presumably is a species of learning or adaptation with insight. Where perception of relations occurs, successful or adequate adaptation tends to appear immediately and definitely. By one or another authority it is asserted that this occurs in gibbon, orang-outan, chimpanzee, and gorilla. Positive evidences are most numerous for the chimpanzee. For the siamang no pertinent reports have been discovered. Probably the order of increasing importance, frequency, and complexity of behavioral adaptation with insight in the anthropoid types is: gibbon and siamang, orang-outan, gorilla, chimpanzee.

Attention with foresight, and therefore involving anticipation of events and preparedness, has not been demonstrated in gibbon or siamang. It appears in each type of great ape. The evidences vary considerably in value for the different types and the order of increasing importance at present indicated is: orang-outan, gorilla, chimpanzee. Undoubtedly behavioral adaptations on the basis of insight, foresight, and the psychobiological phenomena which these terms imply, are of extraordinary significance in the life of the anthropoid apes and in primate evolution.

Memory—delayed response. Memory, it is true, is complex and differs extremely in nature as well as in psychobiological value among organisms. For the anthropoids value and temporal span appear to increase from gibbon and siamang, through orang-outan and chimpanzee, to gorilla. Memory for place or location is known to be excellent in orang-outan, chimpanzee, and gorilla. Observations are lacking for gibbon and siamang. Likewise, in the great apes appear evidences of "familiarity" and "recognition" suggestive of human experience and expression. In gorilla and chimpanzee memory for isolated or dissociated qualities of objects has been experimentally established. In the present state of knowledge significant contrast is between anthropoid memory and that of inferior and superior primates. Almost certainly the memory processes of chimpanzee and gorilla, possibly also of orang-outan, more closely than those of any other organism resemble the human.

Imagination. Anthropoid behavior increasingly through gibbon and siamang, orang-outan and gorilla, to chimpanzee, is inventive, constructive, and indicative of ability to analyze and synthesize, in varying degrees, sensory and perceptual experience. The literature indicates by far the highest order of originality or constructiveness in the chimpanzee. At the opposite extreme, with little reliable evidence available, are gibbon and siamang, while for orang-outan and gorilla the evidences, although less abundant than for the chimpanzee, suffice to establish an intermediate rank. As in the case of memory, it may safely be prophesied that further and more ingenious and systematic study of creative imagination, and those forms of behavioral adaptivity dependent upon or associated therewith, will increasingly exhibit resemblance between anthropoid ape and man. At present it would appear that the gorilla of all the anthropoid types is best endowed in memory or reproductive imagination, whereas the chimpanzee ranks first in creative imagination.

Instrumentation. Tendency to use objects as implements, rare among other mammals, is an extraordinarily important form of behavioral adaptation, and phase of progress, in the anthropoid apes. It is indeed the prophecy or threat of steadily increasing control of environment. Instrumental use of objects by anthropoid apes has rarely been

observed in nature, but it is not uncommon in captivity. General observation and experimental inquiries combine to support, as order of increasing instrumentation: gibbon and siamang, gorilla, orang-outan, chimpanzee. In the Hylobatidae possibly the tendency is lacking, in orang-outan and chimpanzee it is readily observable, while in gorilla it appears to be less strong.

Adaptation of environment versus self-adaptation. The manipulation of environment to achieve behavioral adaptation, and especially the construction or fashioning of tools, are highly significant of the gulf between anthropoid apes and other infrahuman mammals. It is a long step from the instrumental use of a natural object to efforts at constructive adaptation. Evidences for tool fashioning have not been reported for gibbon or siamang. They are few for gorilla and orang-outan, but for chimpanzee, much more numerous and valuable. We therefore infer that the tentative order of approach to or increase in tendency and ability to adapt environment to individual needs (constructiveness) is: gibbon and siamang, gorilla, orang-outan, chimpanzee.

Mechanical ability. Aptitude for manipulation of simple mechanisms and acquisition of skill in connection therewith are of wholly peculiar interest and practical importance to man, since they are immediate conditions of material progress. Virtually lacking in other mammals, mechanical ability is observable in several of the primates and especially in the anthropoid apes and man. Among anthropoid types appear surprising differences. Evidence for gibbon and siamang is lacking; in gorilla a very low order of mechanical aptitude and skill is indicated; in chimpanzee, gift approaching genius, and in orang-outan an intermediate condition. Therefore the tentative order of increasing ability: gibbon and siamang, gorilla, orang-outan, chimpanzee.

Ratings for behavioral adaptivity. Rate or quickness of learning is a commonly used, and, in certain respects most significant, measure of docility. The heterogeneous data available suggest as order of increase: gibbon and siamang, gorilla, orang-outan, chimpanzee. Certainly this order might be expected to differ with type of problem. The rating applies to relatively difficult adjustments.

Rating is possible also for *range,* that is, the order of difficulty which the organism can master; *variety* or the diversity of problem which may be solved, and *general adaptation* or degree of generalization. For these several aspects of adaptivity the indicated order of increase is: gibbon and siamang, orang-outan, gorilla, chimpanzee.

Psychological resemblances to man. When affective traits are considered the order of increasing resemblance appears to be: siamang and gibbon, orang-outan, gorilla, chimpanzee; and when cognitive traits are examined: siamang and gibbon, orang-outan, chimpanzee and gorilla. A combined order is not clearly indicated by present information. Our examination of the varied evidences, combined with personal experience, suggests: gibbon, siamang, orang-outan, chimpanzee and gorilla. This we grant is not justified by the ratings of the preceding paragraphs. Our explanation of what must seem a discrepancy is that the chimpanzee has been much more extensively and carefully studied than any other anthropoid. Were correspondingly varied and satisfactory data available for gorilla, it might command first place in psychological resemblance to man even if less alert, docile, imitative, and suggestible than the chimpanzee.

TABULAR RÉSUMÉ

A FURTHER step in summarizing materials is suggested as desirable. It is the tabular arrangement, for convenient consultation, of those facts relative to anthropoid traits and comparisons which are essential to the psychobiologist as basis for intelligent and effective use of the anthropoid apes as subjects of observation and as experimental objects.

The table which we have prepared is both *résumé* of the foregoing summary and sup-

plement to it, since more traits are included than could be mentioned in the text. Summaries, comparisons and conclusions, tabular *résumé,* and detailed subject and author index have been prepared as aids to the use of the factual materials of this volume; they are not substitutes for the descriptive chapters.

SYNOPTIC COMPARISON OF ANTHROPOID APES

Characters	*Gibbon*	*Siamang*	*Orang-outan*	*Chimpanzee*	*Gorilla*
Date of first scientific description	1697, Le Comte, poor; 1766, Buffon, good; 1771, Linnaeus, excellent	1820, Desmarest	1658, Bontius	1641, Tulp	1819, Bowdich, poor; 1847, Savage and Wyman, excellent
CONFIGURATION					
Build	Relatively tall, slender, and light-limbed; chest larger than abdomen, which is greyhound-like	Somewhat larger than gibbons	Relatively short and stocky, loosely built, abdomen larger than chest	Stocky, strongly built, chest and abdomen well developed	Relatively massive, huge shoulders, broad back, well-developed chest, and immense abdomen
Height	Approximation, irrespective of sex, 32 inches ± 20%	Approximation, irrespective of sex, 34 inches ± 20%	Approximation, irrespective of sex, 48 inches ± 20%	Approximation, irrespective of sex and species, 50 inches ± 20%	Approximation, irrespective of sex and species, 60 inches ± 20%
Weight	Species and sex variations included, 10 pounds ± 20%	Sex variations included, 20 pounds ± 20%	Sex variations included, 160 pounds ± 20%	Sex and species variations included, 150 pounds ± 20%	Sex and species variations included, 300 pounds ± 20%. The male mountain gorilla may exceed 400 pounds
Coat	Fine, woolly, thick, white, gray, black, mixed or concolored	Relatively coarse, straight, thick, black	Coarse, straight, often long, light to dark reddish	Coarse, straight, relatively sparse, black, grayish, or dark brown	Coarse, sometimes woolly on abdomen, relatively abundant, black, grayish, in places rufous
Skin	Usually brown to black, naked regions black	Usually dark brown to black, naked regions jet black	Usually brown, sometimes purplish or grayish, gooseflesh conformation common, naked regions light to dark brown	Caucasian white to dark brown, naked regions brown to black	Dark brown to black, naked regions usually black
Head	Small, roundish, orbits large, supra-orbital ridges marked, otherwise skull relatively smooth	Essentially as in gibbon	Relatively high and pointed, supra-orbital ridges prominent, cranial ridges present, also sometimes small crest, forehead often depressed in center	Head elongated, supra-orbital ridges large, no central crest	Head relatively large, brain cavity relatively small, supra-orbital ridges massive, central crest very large

Characters	*Gibbon*	*Siamang*	*Orang-outan*	*Chimpanzee*	*Gorilla*
Ears	Pinna relatively large and prominent except as concealed by hair, there is no lobule	As in gibbon	Pinna relatively small, set close to head, inconspicuous, and without lobule	Pinna usually large, outstanding, very conspicuous, sometimes small, there is a small lobule	Pinna relatively small, set close to head, and inconspicuous, the lobule sometimes is conspicuous
Nose	Relatively small, elevated, less flat than in great apes, nostrils less conspicuous, opening downward and outward	As in gibbon	Extremely flat, relatively inconspicuous except at tip, bridge depressed, nostrils smaller than in chimpanzee and gorilla	Flat, more conspicuous than in orang-outan and less so than in gorilla, median groove common, nostrils large	Large, conspicuous, triangular, flat, nasal bridge long, wings and nostrils large
Laryngeal sacs	Absent	Large, covered by fold of naked black skin, very conspicuous when inflated	Conspicuous, goiter-like in appearance when inflated	Present but inconspicuous	Present but inconspicuous
Larynx	Ranked second in resemblance to the human vocal mechanism	Present, ranking not available	Ranked fourth in resemblance to the human	Ranked first in resemblance to the human	Ranked third in resemblance to the human
Arm	Very long, relatively and absolutely the longest in anthropoid apes	As in gibbon	Very long	Longer than leg, but the two are more nearly equal than in other apes	Long, heavy
Hand	Very long and narrow	As in gibbon	Long and narrow as compared with gorilla and man	Length and width intermediate between orang-outan and gorilla, length greater than in foot	Shorter and broader than in orang-outan and chimpanzee, length less than in foot
Fingers	Very long and slender, thumb short	As in gibbon	Long and slender, thumb diminutive	As in orang-outan, thumb not so diminutive as in orang-outan	Relatively shorter and thicker than in other apes, thumb as in chimpanzee or larger
Nails	Nail of thumb commonly flat, other nails may be arched or claw-like	As in gibbon	Nails flat or arched	Nails flat or arched	Nails flat or arched

Characters	*Gibbon*	*Siamang*	*Orang-outan*	*Chimpanzee*	*Gorilla*
Leg	Relatively short and less well developed than arm	As in gibbon	Shorter and less well developed than arm	As in orang-outan	Larger than in other great apes, but shorter and less well developed than arm
Foot	Long and narrow	As in gibbon	Long and narrow	Shorter and broader than in orang-outan, and also than hand	Relatively short and broad as in man
Toes	Long, hallux relatively large and heavy	As in gibbon	Long, hallux diminutive	Long, hallux larger than in orang-outan	Short, thick, webbed, hallux short and thick
Nails	Nails commonly arched or claw-like	As in gibbon	Nails flat or arched, hallux sometimes lacks nail	Nails flat or slightly arched	Nails flat or slightly arched
Ischial callosities	Present, small	As in gibbon	Usually absent	Usually absent, sometimes present, small	Usually absent, rarely rudiments present
Tail	Absent	Absent	Absent	Absent	Absent
PHYSIOLOGICAL					
Strength	Remarkable strength of arm, and physical endurance	Relatively great, as in gibbon	Muscular strength several times greater than in man	Comparable with that of orang-outan	Tremendous, far greater than in any other primate
Hardiness	Ranked relatively low, described as "delicate"	As in gibbon	Relatively hardy, ranked next to chimpanzee	Most hardy, it is said, of all anthropoids	Ranked low because of poor adaptation to captivity
Sweat glands, odor	No report found	No report found	Glands present, neither secretion nor odor reported	Glands present, secretion observable, odor reported for only one species (Tschego), probably present in all	Glands present, secretion often abundant, strong odor
SPECIES AND HABITAT					
Species	Probably eight or more species	One species	One species, several subspecies or races	Probably eight or more species, fourteen are listed	One or two species, a few races

Characters	*Gibbon*	*Siamang*	*Orang-outan*	*Chimpanzee*	*Gorilla*
Dimorphism	Age and sex dimorphism	Sex dimorphism	Sexes extremely different in appearance	Sex dimorphism	Sex dimorphism
Variability	Extreme variability of coat color	Not described	Great variability as in man	Great variability as in man	Variability said to be even greater than in man
Distribution	South China, Malay Peninsula and Archipelago, Island of Hainan	Sumatra and possibly the Malay Peninsula	Borneo and Sumatra	Equatorial Africa from West Coast to Belgian Congo	Equatorial Africa: Cameroons, Gaboon, Belgian Congo
Habitat	Upland forests to altitudes of some 5,000 feet	From sea level to upland regions in forests	In swampy, alluvial forests and along river courses	In lowland and upland jungles and forests	*G. gorilla* in lowland jungles. *G. berengei* in highlands and mountains to 10,000 feet
Abundance	Numerous in many regions	Plentiful in a relatively small area	Sparsely distributed and supposed to be diminishing	Probably most abundant of all the great apes	Rarest of anthropoids, only a few thousand specimens in existence
MODE OF LIFE					
Locomotor habit	Arboreal, first rank	Arboreal, second rank	Arboreal, third rank	Arboreal and terrestrial, fourth rank in arborealness	Terrestrial and arboreal, fifth rank in arborealness
Agility	Remarkable, first rank	High, second rank	Relatively low, fourth rank	Relatively high, above orang-outan and gorilla, third rank	Lowest of all the great apes, fifth rank
Quickness	Extreme, first rank	High, second rank	Relatively low, fourth rank	Relatively high, third rank	Low, fifth rank
Bipedal walking	Naturally stand erect and walk bipedally, when on ground	As in gibbon	Stand erect and walk bipedally awkwardly and with difficulty	Stand erect and walk bipedally more readily than orang-outan, but with difficulty	Stand erect and walk bipedally somewhat more naturally and readily than the chimpanzee
Quadrupedal walking	Unnatural and unusual even when forced to the ground	As in gibbon	Natural mode of locomotion when forced to the ground. Weight rested on outer edge of foot and on knuckles	Natural and easy mode of terrestrial locomotion. Weight on sole of foot and on knuckles	Primary mode of locomotion. Weight on sole of foot and on knuckles

Characters	*Gibbon*	*Siamang*	*Orang-outan*	*Chimpanzee*	*Gorilla*
Climbing	Consummate skill, swings through trees by arms with legs drawn close to body	Skill, as in gibbon, but less grace, speed, and agility	Sure, skilful, but relatively slow, uses both hands and feet	Skilful, swift, venturesome, uses both hands and feet	Least skilful of all, relatively slow, cautious and clumsy in climbing
Jumping	Legs not ordinarily used for propulsion, jumping possible on ground	As in gibbon, may hop along on ground	Capable of jumping, but does not do so willingly in trees or on ground	Jumps freely and skilfully in trees or on ground	Ordinarily jumps only when forced to do so
Swimming	Not reported	Not reported	Evidence mostly negative, probably does not swim naturally and willingly	As in orang-outan, evidence mostly negative	Uncertain, swimming of rivers reported
Dancing	Neither dance movements nor fondness for rhythm reported	As in gibbon	Not reported in nature, observed rarely in captivity	Varied and frequent, obvious fondness for rhythmic movements of limbs and body	Dancing not reported, but rhythmic pounding or beating common
Handedness	Not reported	Not reported	Preference reported, not uniformly right- or left-handed	As in orang-outan	As in orang-outan
Throwing	Not reported	Not reported	Observed by reliable authorities	Frequently reported, more skilful than in orang-outan	Awkward and inaccurate as in orang-outan
Nest building	Not reported	Not reported	Tree nests commonly built, may be used repeatedly	Tree nests commonly built, usually used only once, more elaborate than orang-outans'	Ground and tree nests built, less elaborate usually than orang-outans' and chimpanzees'
Sleeping posture	Sitting upright in crotch of tree holding fast with hands, feet, or both	As in gibbon	Lying on back or side in nest-bed, in human posture	As in orang-outan	As in orang-outan, or sitting upright with back against tree
Diet	Vegetarian	Vegetarian	Vegetarian, readily accustomed to mixed diet in captivity	Vegetarian, readily fed in captivity, adaptable	Herbivorous or frugivorous, relatively difficult to feed in captivity

Characters	*Gibbon*	*Siamang*	*Orang-outan*	*Chimpanzee*	*Gorilla*
Drinking	Water sucked from arm or hand, in trees	As in gibbon	As in gibbon, or by applying lips to surface and sucking	Usually by applying lips to liquid	As in chimpanzee
Cleanliness	Person is kept perfectly clean	As in gibbon	Cleanly in person and nest, sex habits also said to be cleanly	As in orang-outan	As in orang-outan
CAPTIVITY					
Capture	Usually by shooting female with young	As in gibbon	As in gibbon	As in gibbon, or with nets	As in gibbon, or with nets
Effects of captivity	Highly unfavorable, usually die soon	As in gibbon	Stands captivity better than gibbon and occasionally lives long	Stands captivity best of all the anthropoids, highly adaptable	As in gibbon, most difficult to maintain in captivity
Tamability	Young ranked high, on par with chimpanzee	Less readily tamed than gibbon	Young ranked next to chimpanzee, extremely variable	Most readily tamed of all the great apes	Ranked low, many individuals difficult to tame
Domestication	Training to human service not reported	As in gibbon	Never completely domesticated, rank highest of all	Less domesticable than orang-outan, unwilling to "work"	Ranked lowest of the great apes
Diseases	Disorders of respiratory and digestive systems probably indicate improper care in captivity	As in gibbon	Varied in captivity, as for man, due mostly to improper nutrition and hygiene	Most captives die from disorders of respiration, digestion, or elimination	As in orang-outan and chimpanzee
SOCIAL RELATIONS					
Gregariousness	First rank in gregariousness	As in gibbon	Adults often solitary, sexes may segregate, fourth rank, lowest	Less gregarious than gibbon, third or second rank	Possibly more gregarious than chimpanzee, second or third rank
Leadership	Yes, essential in gregarious life	As in gibbon	Dominance of male	Social group led by a dominant male	As in chimpanzee
Sociability	Highly developed, dependence extreme	Deemed less than in gibbon	Least sociable of anthropoids	Extremely sociable, first rank among great apes	Probably less sociable than chimpanzee, but ranked next to it

Characters	*Gibbon*	*Siamang*	*Orang-outan*	*Chimpanzee*	*Gorilla*
Playfulness	Marked, varied, even adults are mischievous	As in gibbon, as far as known	Rapidly disappears in maturity, ranks below chimpanzee	Most gifted in play of all the great apes	As in orang-outan
Nomadism	Marked, rove in search of food	As in gibbon	Wander in search of food, less nomadic than other great apes	Marked tendency, restless disposition seems to impel to wandering	Marked as in chimpanzee, but chiefly for food and camp grounds
Migration	Not reported	Not reported	In response to seasonal distribution of foods	Probably as in orang-outan	Probably as in orang-outan
Social unit	Band or herd	Band or herd	No stable group	Family, band as composite	Family, band as composite
Segregation of sexes	At times, if not regularly between breeding seasons	Not reported	At times if not regularly	Not reported	Not reported
Family	Not reported as unit of band	Not reported as unit of band	Reported as temporary	Seemingly permanent and constituted by parents and offspring	Seemingly stable, and consisting of male, females and young
LIFE HISTORY					
Menstruation	Said to be monthly	Not reported	As in gibbon	Monthly	Probably monthly, not certainly observed
Gestation	Thought to be seven months	As in gibbon	Thought to be nine months	As in orang-outan	As in orang-outan
Weight at birth	Unknown	Unknown	Thought to range from three to seven pounds	Thought to approximate that of orang-outan	Thought to approximate that of orang-outan
Rate of growth	More rapid than in great apes	As in gibbon	Thought to approximate that of man	As in orang-outan	As in orang-outan
Sexual maturity	Probably achieved in five to eight years	As in gibbon	Probably achieved in eight to twelve years	As in orang-outan	Probably achieved in ten to fourteen years
Longevity	Estimate, twenty to thirty years	As in gibbon	Estimate, forty to sixty years	Probably as in orang-outan	Probably as in orang-outan

Characters	*Gibbon*	*Siamang*	*Orang-outan*	*Chimpanzee*	*Gorilla*
AFFECTIVE TRAITS					
Disposition	Shy, wary, timid, gentle, good-tempered, affectionate	As in gibbon, but noticeably less so	Lethargic, phlegmatic, pensive, or melancholy	Relatively active, excitable, nervous, impulsive, buoyant	Calm, deliberate, reserved, self-dependent
Emotional expressiveness	High, quick in emotional response	Somewhat less expressive than gibbon	Much less expressive than chimpanzee, and more so than gorilla	Very high, quick, varied, intense	Very low, inhibition or repression indicated
Temper tantrums	Quick to express resentment or anger	As in gibbon	May appear as in child	Commonly exhibited	Have not been observed
Moody	Not reported	Not reported	Markedly	Slightly, least moody of the great apes	Very, most moody of the great apes
Noisy	Very noisy, but produces few sounds	As in gibbon	Silent, seldom vocalizes if undisturbed	Very noisy, vocalizes much and variously	Noises chiefly nonvocal, made by beating body or other objects
Vocalization	Cries penetrating, but not highly varied	As in gibbon	Grunts, squeaks, screams, roars	Nearest approach to human vocalization, many distinguishable sounds produced	Grunts, whines, screams, roars
Nonvocal sounds	None reported	None reported	Pounding, occasionally on ground or objects with hands and arms	Pounding on ground or objects with hands, feet, or both	Beating chest, cheeks, chin, hollow trees with open or clenched hands
Speech	Presence not indicated	Presence not indicated	Hint of, but extremely rudimentary	Beginnings of, in affective vocalization	Presence not indicated
Intercommunication	Little known	Little known	Less highly developed than in chimpanzee	Highly developed, based rather on visual than auditory stimuli	As in orang-outan
SENSES					
Sight	Supposed to be well developed	As in gibbon, little known	No experimental analysis	Achromatic and chromatic vision, seemingly as in man	No experimental analysis

Characters	*Gibbon*	*Siamang*	*Orang-outan*	*Chimpanzee*	*Gorilla*
Hearing	"Keen," no accurate observations	As in gibbon, presumably	No experimental analysis	Discrimination of noises and tones demonstrated	No experimental analysis
Touch	No data	No data	No experimental analysis	No experimental analysis	No experimental analysis
Taste	No data	No data	Supposedly as in man	Supposedly as in man	Supposedly as in man
Smell	No data	No data	Supposedly as in man	Supposedly as in man	Supposedly as in man
Pain	No data	No data	No data	No data	No data
Visual space	No data	No data	No experimental analysis	Size, form, and depth perception, binocular vision	No experimental analysis
"INTELLIGENCE"					
Curiosity	Distinctly less than in great apes	As in gibbon	Less, it seems, than in chimpanzee	Marked, with varied and persistent expressions	Less, it seems, than in chimpanzee
Attention	Inferior to that of the great apes	As in gibbon	Voluntary, concentrated, sustained	More highly developed than in orang-outan	As in chimpanzee
Imitation	No experimental studies	No experimental studies	Ranks with gorilla, next to chimpanzee	More important than in any other great ape	As in orang-outan
Tuition	Inferior to great apes	As in gibbon	Ranks second among great apes in docility	Ranks first among great apes in docility	Ranks third among great apes in docility
Perception of relations	Little known	Little known	Indicated by a few observations	Repeatedly observed	Information scanty
Insight	Inferior to great apes	Information lacking	Present, but inferior to that of chimpanzee	Ranks first of great apes	Present, but inferior to that of chimpanzee
Foresight	No experimental studies	No experimental studies	Evident, ranks third of great apes	Evident, ranks first of great apes	Evident, ranks second of great apes
Memory	No comparable measurements	As in gibbon	Information meager, probably ranks third	Excellent visual memory	Excellent visual memory
Imagination	No experimental analysis	No experimental analysis	Indicated as important	Ranks first among great apes	Indicated as important

Characters	*Gibbon*	*Siamang*	*Orang-outan*	*Chimpanzee*	*Gorilla*
Use of implements	Not reported	Not reported	Observed occasionally	Observed repeatedly	Observed less often than in other great apes
Construction of implements	Not reported	Not reported	Reports less convincing than for chimpanzee	Several times observed, ability present	Reports less convincing than for chimpanzee
Mechanical ability	Not reported	Not reported	Inferior to that of chimpanzee, apparently	Present in marked degree	Inferior to that of chimpanzee and orang-outan, apparently
Inventiveness	Meager so far as known	As in gibbon	Evident, but distinctly inferior to that of chimpanzee	Ranks first among the great apes	Inferior to that of chimpanzee and orang-outan
Speed of adaptation	Slower than in great apes	As in gibbon	Second rank among the great apes	First rank among the great apes	Third rank among the great apes
Range of adaptation	Indicated as less than in great apes	As in gibbon	Ranks next to chimpanzee, so far as known	Ranks highest among the great apes	Ranks lowest among the great apes
Variety of adaptation	Indicated as less than in great apes	As in gibbon	Less, apparently, than in chimpanzee	Greatest among the great apes	Less, apparently, than in chimpanzee and orang-outan
General adaptation	Information meager	As in gibbon	Less obviously important than in other great apes	Marked, often observed	Marked, ranks next to chimpanzee
Rank in affective resemblance to man	Fourth	Fifth	Third	First	Second
Rank in cognitive resemblance to man	Fourth or fifth	Fifth or fourth	Third	Second or first	First or second
Rank in psychobiological resemblance to man	Fifth or fourth	Fourth or fifth	Third	Second or first	First or second

CHAPTER FORTY-FIVE

COMPARISON OF PRIMATE TYPES

IN the preceding chapter the anthropoid types, to the consideration of whose psychobiology this volume is devoted, were summarily compared. We purpose in the present chapter to compare similarly the principal primate types. We shall thus increase the range of comparison by including all primates instead of limiting survey to the highly organized gibbons and man-like apes, but we shall necessarily decrease its scope by attending almost exclusively to mental status and behavioral phenomena. Initially it was our plan to make comparison of six primate groups which represent widely divergent types: lemur, tarsius, monkey, gibbon, ape, and man. But after assembling materials we decided, on account of relative dearth of reliable and precise information concerning tarsius and gibbon, and because of the desirability of brevity and simplicity of presentation, to reduce the compared types to four: namely, lemur, monkey, ape, and man. These four assemblages of primates differ extremely both morphologically and physiologically. Each group also includes widely diverse organisms.

The factual materials on which we base our comparative statements are taken in the main from the scientific literature, but also to an important extent from our unpublished observational experience with representatives of all types except lemur.

Since they do not logically belong in the bibliography on the psychobiology of anthropoid apes which appears at the end of this volume, we shall present our principal sources of information on lemur, tarsius, and monkey in a numbered list at the end of this chapter. Throughout the chapter reference to titles in this special list is by number instead of by date of publication as heretofore in connection with the anthropoid bibliography. This fact is emphasized to avoid confusion.

CONFIGURATIONAL AND NEUROLOGICAL CONTRASTS

ON the assumption that attention may more profitably be concentrated on psychobiological facts than distributed among them and a multiplicity of structural considerations, we shall devote but a few sentences to the latter before proceeding with our primary task.

Size of organism increases steadily and rapidly from lemur to man. There are lemur-like primates as small as a rat, others larger than the cat. Likewise among the monkeys appear the diminutive marmoset and the large baboon which, greatly exceeding the size of gibbon and siamang, falls considerably short of that of the great apes. Only if we include gibbons and siamang with the great apes is the average size in this group less than that of man. Gorilla is considerably larger than man and, indeed, the largest existent primate.

A tail, varying greatly in structure and relative length, is present and functional as auxiliary balancing, steering, or grasping organ in lemur and monkey and absent in ape and man. The only exceptions to this generalization appear in the monkeys, a few of which have very diminutive or rudimentary tails.

Almost as striking as contrasts in size of body are those in configuration of the head, for there is progressive change between lemur and man from a rodent-like elongated head, with conspicuous muzzle, to the approximately spherical and short-jawed condition in man. As the muzzle diminishes in length and the head gradually approaches spherical form, the facial angle rapidly increases.

Particularly notable, and also of biological significance, are the contrasts in the configuration of the brain. In certain lemur-like creatures appear almost smooth surfaced and relatively small cerebral hemispheres which only partially cover the cerebellum, whereas in the great apes and man the cerebrum is relatively large, definitely lobated and richly convoluted. The changes are progressive from lemur to man, for in general the monkey brain is much more humanoid than that of lemurs and much less so than that of manlike apes. Within each of our four primate groups appears definite transition from relatively simple and primitive brain structure in the smaller genera and species to much more complex and humanoid conditions in the larger representatives. This generalization is notably true of lemur and its like, of monkeys, and of anthropoid apes, if with them gibbon and siamang be included. Perhaps chiefly because of this observed direct relationship between body size and complexity and order of development of the brain, the larger representatives of the four primate types are thought to be more intelligent than the smaller. Inference from structure to psychobiological function is difficult and involves incalculable risks. In this particular case we are not convinced by the varied evidences that the suggested generalization is correct. The gorilla, largest of the primates, is said most closely of all to resemble man in the configuration and proportions of its brain. Inference from structural to functional similarity therefore would justify the statement that it is also next to man in mental development. Psychobiological investigations indicate instead that the smaller-sized chimpanzee, with its somewhat less humanoid brain, in many respects is superior to gorilla. In the midst of this comparison we venture therefore to suggest, as worthy of inquiry, the question: Does configuration of the brain as a whole, or of the cerebral hemispheres, indicate mental status, or is size of organism an important factor?

We would refer the reader to Tilney's *The Brain from Ape to Man* for detailed comparative description of the primate nervous system. Our paragraph suffices merely to point the extreme importance of neurological fact for the psychobiologist.

MODE OF LIFE

From the vast array of observations and generalizations concerning mode of life in the primates, for use in this section we have necessarily selected in accordance with relative satisfactoriness and importance of knowledge. Our survey therefore is incomplete and our comparisons relatively few but highly significant.

Locomotor habit. Between lemur and man appear the extremes of arborealness and terrestrialness. In lemur-like primates appear remarkable agility, skill, and quickness in climbing, running, and jumping, and, by contrast, in gorilla and man relatively slow, deliberate, cautious climbing, walking, and running. Within our four types, as well as in the entire group of primates, arborealness is inversely related to size. Among the Prosimiae, which include lemurs and several other types of primitive primate, speed and dexterity of movement are marvelous. Many of these creatures seem rather to fly among the trees than to climb. In the monkeys there is wide range of locomotor habit, for whereas many are extremely arboreal, quick and agile, others, like the baboon, are either primarily or exclusively terrestrial. Likewise diversity appears in our third group, for the pro-anthropoid gibbon and siamang are highly arboreal, while approach to terrestrialness is observed progressively in the series: orang-outan, chimpanzee, gorilla. But despite diversity of locomotor habit within types there is gradual transition in the series lemur, monkey, ape, man from exclusively arboreal habit to exclusively terrestrial. This profound change involves significant structural adaptation of limbs and extremities and as well many associated adapta-

tions of behavior, of which some are mentioned in the following paragraphs.

Manual dexterity. The phrase suggests specialization in the use of the hand. Discoverable in our chosen types of primate is definite trend from quadrupedal to bipedal activity and from the submanual to the definitely manual. In lemurs all four extremities are used primarily as feet; in monkeys the anterior extremities are more frequently and skilfully used as hands, although they are still requisite for arboreal and terrestrial locomotion. Specialization is much more pronounced in the apes and it is fitting to characterize orang-outan, chimpanzee, and gorilla as definitely manual types. Nevertheless, and despite increasing specialization of function, the anterior extremities continue to be used as organs of locomotion. Man alone exhibits extreme specialization in use of hand and foot, with almost complete disappearance of overlap. Although it is clear that the appearance of bipedal locomotion tends to facilitate specialization in the use of the hands and acquisition of manual skill, it is likewise apparent that in certain monkeys and in the apes the anterior extremities are in large measure relieved of locomotor function and may on occasion be used as hands. Needed are satisfactory methods of measuring manual dexterity. (See Morton, 26a.)

Nesting and sleeping. Discoverable, as we compare types from lemur to man, is replacement of willingness to accept and utilize what nature happens to provide by definite and systematic effort to adapt environment in the interests of welfare and comfort. This generalization is supported by the observed nesting and sleeping habits of the primates. Ordinarily sleeping nests or beds are not constructed by lemur, monkey, gibbon, or siamang. By certain of the genera and species in these assemblages of organisms shelters are occasionally or regularly constructed for female and young. The three types of great ape, on the contrary, regularly build tree or ground nests as resting and sleeping places and as shelters for female and young. All, however, are temporary constructions which are used either once or at most a few times before being abandoned. Never, so far as recorded, are they built as shelters from inclement weather.

Man has introduced relative permanency of construction, together with features which provide for protection against unfavorable changes in temperature and moisture and for physical comfort. The observed range of variation is from almost complete lack of tendency and capacity for construction of nest or bed to their definite presence in the anthropoid apes and their relatively high development in man. This comparison is peculiarly significant because nesting behavior illustrates the appearance and phylogenetic development of constructivity, and, coincidentally, the transition from complete dependence on self-adjustment to increasing dependence on manipulation or modification of environment as a method of behavioral adaptation.

As sharply contrasted as are the nesting activities of the primate types are their sleeping postures. The range, it appears, is from sleeping sitting upright or bent over, with hands, feet, or both, grasping supporting objects, to the typical human relaxed position on back or side. Monkeys, and even gibbons and siamang, ordinarily sleep in sitting posture, supported or stabilized by hands and feet, whereas orang-outan, chimpanzee, and gorilla, like man, lie completely relaxed on back or side, often with the head pillowed on one or both arms. Authoritative statement concerning the sleeping habits of free wild Prosimiae cannot be made. Probably they as often lie rodent-like in natural shelters as sit monkey-like. But however this may be, convincing evidence of nest-building tendency comparable with that which appears in the anthropoid apes has not been reported.

Foods and feeding. Possibly, although we are by no means certain, feeding habits become less specialized and the organism more adaptable from lemur to man. In

any event, definite direction of nutritional change or adaptation has not been discovered. In primates other than man, production, hoarding, and preservation of food are unknown. This, we are reminded, may be due to the relative abundance of foodstuffs in the habitat of lemur, monkey, and ape. Possibly, but rather we suspect the restricted distribution of these organisms and their occurrence with few exceptions only in tropical or subtropical climates are due chiefly to their inability to adapt to extreme variations in the nature, regularity, and abundance of food supply. Such nutritional contrasts as are observable among the types lemur, monkey, ape, and man do not, so far as is revealed by the pertinent literature, possess genetic significance.

Response to captivity. From lemur to man it seems to be increasingly difficult to keep primates healthful and contented while in captivity. Suggested is the generalization that the more highly organized the animal psychobiologically the more difficult it is to supply and maintain satisfactory conditions for life in confinement. Evidently this general statement holds also for breeding, for recorded experience definitely indicates that the Prosimiae, which include the lemurs, of all primates breed most readily and freely when confined. Next in order of reproductive adaptiveness stand the monkeys. Gibbons breed occasionally in semi-captivity, but rarely when caged. The chimpanzee has seldom been successfully bred, and with only one recorded exception, never reared from birth to maturity in captivity. For orang-outan there is only one record of breeding in captivity, and for gorilla, none. To complete the comparison we venture the surmise that in conditions comparable with those ordinarily established for captive anthropoid apes, man would breed as seldom as do they.

Comparison of types establishes increasing rapidity and extent of adaptation to man, from lemur to ape. This secure generalization is highly important as indication of contrast in mental status and direction of evolution. Timidity, it is said, never completely disappears in the captive lemur and rarely in the captive monkey, whereas in the great apes complete confidence in human caretaker and in other environmental objects may be achieved. The difference, exhibited by lemur, monkey, and ape, in the degree to which timidity and distrust may be replaced by assurance and confidence can best be appreciated by those who have attempted to care for and observe representatives of the several types of primate in captivity.

Correlated with the form of behavioral adaptation which we have designated as "confidence" is the tendency to coöperate with human attendants. This also increases obviously and very markedly from lemur to man. Indeed, in lemurs and their like, however long subjected to kindly human treatment, coöperation with man is extremely slight. In monkeys there is variation, in accordance with family, genus, or species, from the scarcely observable to the obvious. While seldom acquiring complete confidence in man and exhibiting willingness to trust themselves implicitly to him and to coöperate effectively with him, their behavior nevertheless may contrast sharply in these respects with that of lemur, and no less sharply with that of anthropoid apes. For in the latter group there appears, as in no other infrahuman primate, degree of confidence in man and of willingness, ability, and skill in coöperating with him which closely approaches intraspecies human relationship and establishes the existence in these animals of kinds and degrees of insight and understanding which are not suggested by the comparable behavior of lemur and monkey. In earlier chapters we have described at length, and endeavored to indicate the psychobiological importance of, voluntary coöperation between infrahuman primate and man. Here, with maximal emphasis, we point the remarkable contrast in respect to capacity for faith or confidence in, and coöperation with, man as between lemur and monkey, and monkey and ape.

In the absence of quantitative observations comparison of magnitudes is hazardous; nevertheless we risk the prophetic surmise that in respect to the forms of behavioral adaptation to captivity in point, the difference between chimpanzee and man is less than between chimpanzee and macacus monkey, or between the latter and lemur.

The content of the preceding paragraph would seem to justify expectation that anthropoid apes should prove highly domesticable. Such, however, is not the case, for although many representatives of each of our types may readily be tamed if captured young, no one of them has ever been thoroughly domesticated and enslaved by man as have many other animals. The most highly organized types of monkey, and the anthropoid apes as well, delight on occasion in varied activities which may simulate human work and possess value for man, but childlike they quickly tire and come to resent long-continued systematic effort, or, indeed, anything which they are obliged to do regularly without immediate reward. Unquestionably, from lemur to ape, there is definite trend toward increasing rapidity and degree of tamability. That the same may be said of domesticability is uncertain. Assuredly no infrahuman primate works, in the human sense of the term, willingly, contentedly, and efficiently under compulsion.

Yet another aspect of response to captivity offers marked contrasts. It is the nature and prevalence of diseases or physical disabilities and their resemblance to those characteristic of man. In many of their important features physiological processes from lemur to ape become increasingly humanoid. Correspondingly, as might be expected, the prevalent diseases of captive primates resemble the human in the order: lemur, monkey, ape. Lacking competence in human and comparative pathology we refrain from discussion of this generalization, which is suggested by available results of post-mortem examination and results of the use of primates as subjects in medical research.

SOCIAL TRAITS

Our difficulties in comparing social traits and relations arise chiefly from incompleteness and uncertainty of knowledge. Because of these disadvantages this section will be brief and its points of comparison and exhibited contrasts, few.

Gregariousness, leadership, sociability, and playfulness. Gregariousness and degree of dependence of the individual on the group tend from lemur to man to diminish, and at the same time to give place to a more definite and stable social unit, the family. There is great diversity within the several types. Lemurs and their kind may live in bands or as mated pairs. Monkeys almost invariably constitute bands, as do also gibbons and siamang, but by contrast the anthropoid apes live either as families or in groups constituted by temporarily associated families. The transition from pronounced gregariousness to family life seems to occur between gibbon and chimpanzee.

Leadership, the dominance of one individual, and variation in social value and influence in accordance with individual traits, apparently tend to become increasingly important from lemur to man. The transition is from the leader of the herd to the patriarchal head of the family.

Likewise, sociability and social dependence, in certain at least of their aspects, tend to increase from lemur to ape, but so also does individualism; and whereas the chimpanzee is extremely sociable and dependent therefore upon its social environment, both orang-outan and gorilla are markedly less so than are certain monkeys and lemurs. Obviously knowledge does not permit of safe generalization. With respect to mutual aid and like expressions of sympathetic interest and altruism there can be no doubt of marked increase in the order: lemur, monkey, ape, man.

The young of most primates are playful. There is no definite indication of quantitative increase among our four primate types, but tendency toward greater diversity in playful activity in correspondence with in-

creasing ingenuity, inventiveness, behavioral adaptivity, and manual dexterity and skill, is observable.

Social institutions. Permanency of mating, although not definitely established for any infrahuman primate, is rendered increasingly probable from lemur, through monkey, to ape, by the nature and abundance of pertinent evidence. The same may be said of monogamy, for although it may exist in any of the four groups which we are comparing, so also, according to pertinent observations, may polygamy. Whether there is definite phylogenetic tendency toward the one or the other type of family it is impossible to say. But in any event the family as social unit seems to become more prevalent and also more stable as we progress from lemur to man.

There are a few worth-while observations on property and individual or group ownership, but such as we have discovered suggest, without establishing, the generalization that ownership-behavior is frequently manifested by anthropoid apes, sometimes by certain of monkeys, and rarely if ever by lemur-like primates.

LIFE HISTORY

Of the many psychobiologically interesting and important aspects of primate life history, few are known with reasonable completeness and accuracy and many are almost unknown. We present below, with reservations, those few generalizations which are suggested by the available data.

Courtship and reproduction. Mention of personal adornment and decoration by adolescent and sexually mature individuals we have not discovered in the literature on lemur and monkey, but behavior thus designated has occasionally been reported in the great apes, which, it would seem, in this respect are most similar to man. Sex preference and the persistent rejection or avoidance of certain individuals have been observed often in apes, less frequently in monkeys, and apparently never in lemurs. Similarly indicative of lemur, monkey, ape, as order of increasing resemblance of reproductive behavior to that of man, are the reported characteristics of oestrus cycle and menstruation. The latter phenomenon, although not definitely reported for the lemur, has repeatedly been observed and described in monkey and ape. In no primates except *M. rhesus* monkey and man are the characteristics of the oestrus cycle definitely known and, as well, the periodicity of menstruation and the duration of gestation. With reference to the latter, it is established that the term increases from lemur to man. The periods indicated by available data are: Four to five months for lemur, six to seven months for monkey, seven to nine months for apes, and nine months for man. The duration is known exactly only for man and *M. rhesus* monkey.

Relations of parent and young. From lemur to man the young at birth become relatively smaller and less mature. This generalization is often otherwise stated as increase in the duration of infancy. In lemur the newborn are relatively very large and so mature that the senses apparently are functional immediately after birth and the organism capable within a few hours of locomotor activity. To save words, we have attempted in the accompanying table to represent rate of development roughly and comparatively. For this purpose we have chosen six functional stages which are more or less definitely marked: Condition at birth; duration of complete dependency on mother; age of independent locomotion; period of suckling by mother; age of social independence, at which if necessary the individual may take care of itself; and, finally, age of sexual maturity. Because of variation within types and lack of precise information, the statements presented indicate merely the comparative magnitudes.

Correlated with increased prolongation of infancy from lemur to man are diminishing rate, and extension of period, of growth, and increasing longevity.

TABULAR VIEW OF INDIVIDUAL DEVELOPMENT IN PRIMATE TYPES

	Status at birth	*Period of complete dependency on mother*	*Learns to walk*	*Suckled for*	*Capable of social independence*	*Sexual maturity*
Lemur	Relatively very large, mature, with senses functional	A few hours or days	Within first week, ordinarily	Several days or a few weeks	Within a few weeks	Within a year
Monkey	Relatively large, mature, with senses well developed	A few days or weeks	Within first month, ordinarily	Several weeks	Within 2 to 4 months	Within 2 to 3 years
Ape	Relatively very small and helpless, with senses partially functional	3 to 6 months	Within 6 months, ordinarily	Several months	Within 12 to 18 months	Within 8 to 12 years
Man	Relatively small and helpless, with senses partially functional	At least a year	Within 12 months, ordinarily	1 to 2 years	Within 6 to 8 years	Within 10 to 14 years

AFFECTIVE CONTRASTS

Although they are of the utmost importance psychobiologically, affective traits are extremely difficult to describe briefly and adequately. This is chiefly because quantitative, and other reasonably accurate, forms of description which may be used for comparisons are lacking.

Temperament. The approach to human dispositional characteristics from lemur through monkey to ape is unmistakable and impressive. Temperamentally the Prosimiae, as represented by lemur, more often suggest to the observer such mammals as rats, squirrels, or other small rodents or carnivores, than monkey, ape, or man. By contrast, many representatives of the monkey type are humanoid in their dispositional behavior, and the anthropoid apes more frequently and insistently suggest the affective characteristics of the child than does any other living organism. Such general statements acquire meaning only as one becomes familiar with the organisms themselves and observes their emotional expressions, and especially the extreme differences in variety and type of affective pattern between lemur and man.

Whereas in the anthropoid apes the psychobiologist who is thoroughly familiar with their behavior discovers abundant use for the affective terms feeling, emotion, mood, sentiment, such is not the case in lemur. The generalization suggested by this comparison is that whereas only "feeling" and "emotion" seem obviously applicable to prosimian behavior, the need of such terms as mood and sentiment arises when one attempts to characterize the behavior of monkeys, and becomes increasingly insistent in the order: monkey, ape, man.

Emotional range and expressivity. Significant of contrast is the fact that few emotional patterns have been behaviorally described in lemur and monkey, many in ape and man. Evidently range of emotional expression and degree of expressivity increase rapidly through the types lemur, monkey, ape, man. Only the principal and biologically most primitive patterns are

even mentioned in the literature on lemur, whereas in that on anthropoid apes there appear almost as many as are recognized in man.

Since complete description is entirely impossible it must suffice to indicate certain typical contrasts as between or among lemur, monkey, ape, and man. Impatience, anger, rage, are manifested by all primates, but only in the anthropoid apes, as far as definitely recorded, appears, as strikingly similar to that exhibited by the human child, the temper tantrum. The agreeable emotions of joy, pleasure, delight, if appearing in all primates, are at any rate more readily identified because of increasing similarity to human expression from lemur to ape. Behavior suggestive of smiling and laughter, of practical joking, mischievousness, and appreciation of humor, does not so far as we have discovered appear in lemur. In monkey the descriptions are unconvincing, while in anthropoid ape there is unmistakable closeness of resemblance to corresponding human emotional expression. We are not asserting that any infrahuman primate laughs or appreciates humor as does man. Instead, we note evidence of increasing similarity to human expression and presumably also to human experience from lemur, through monkey, to ape. Humanoid expressions of sympathy, friendliness, affection for man are common in anthropoid apes, much less frequently observed in monkeys, and according to present information rare in the Prosimiae. Apes may on occasion, and frequently do, indicate their sympathetic attitude toward one another or toward persons by stroking, patting, fondling, kissing. Behavior comparable in resemblance to that of man has not been described for monkey or lemur. This holds also for the behavioral patterns of grief, sorrow, depression, and melancholy.

Possibly these contrasts should be attributed in considerable measure to human limitations. Obviously it is relatively much more difficult for man to establish sympathetic relationship and rapport with lemurs and their like than with monkeys and apes. This undoubtedly is due in part to the characteristics of the organisms themselves, but also in a measure to the nature and degree of structural, functional, and experiential differences between observed and observer. As these differences diminish, and such certainly is the case from lemur to ape, mutual confidence, sympathetic relations, and effective rapport become increasingly natural and easy of achievement.

Vocalization and intercommunication. Steadily and markedly from lemur to man vocalization increases in variety and psychobiological value. The cry of the lemur, usually given by the band in chorus, is relatively simple and, as far as known, of narrowly limited affective meaning. By contrast, the screaming, chattering, and definite wordlike sounds produced by one or another sort of monkey are very much more complex and more useful as means of communication. Whether any or all of them possess ideational as well as affective value we do not know. In the apes, whose vocal mechanism is essentially similar to the human, vocalization itself is humanoid and a much greater variety of meaningful sounds is produced than by either monkey or lemur.

Suggested by our present knowledge are the following generalizations. Diversity, complexity, and humanoid characteristics of vocalization increase markedly from lemur to ape. Although evidence of use of the voice and of definite wordlike sounds to symbolize feelings, and possibly also ideas, becomes increasingly abundant from lemur to ape, no one of the infrahuman primates exhibits a systematization of vocal symbols which may appropriately be described as speech. Intercommunication becomes increasingly complex and important in the order: lemur, monkey, ape, man. But whereas in man it depends primarily on vocalization, in the anthropoid apes it is achieved more largely through visual than through auditory reception, since the principal behavioral contributions are facial expression, bodily attitude, gesture, pantomime, and various other incipient or completed movements.

RECEPTIVITY, SENSIBILITY, AND PERCEPTION

The psychobiological phenomena which are designated in the title of this section determine, for the organism, the nature of physical and social environment and therefore primarily condition behavioral adjustment or adaptation. Therefore they are of extraordinary importance in the life of the organism and consequently also to the investigator of behavioral and experiential phenomena. Correct and significant comparisons within this sphere are by no means so simple, obvious, and readily drawn as is frequently supposed and suggested. For contrasts are not necessarily a matter of new modes of reception or sense or of greater or less keenness or acuity. Instead one more often must seek differences in degree of differentiation and complexity within a given mode, or in different sorts and degrees of perceptual ability. The point which we have in mind is well expressed thus: "Seeing" is much more than reception of photic stimuli and the experiencing of certain sensations, for it involves in man, and assuredly also in certain other primates perception and apperception.

With these considerations in mind we turn to the examination of sensory and related phenomena in the primates.

Sense modes. It is not certainly known that any new mode or modes of sense appear between lemur and man. Instead of five senses, man possesses several times that number; we may not safely say ten, fifteen, or thirty, for the list has been added to even in our times. It is entirely possible and even probable that lemur as well as monkey and ape possess as many senses as do we. At any rate, it would be rash at this time to assert that sensibility becomes increasingly complex and serviceable from lemur to man by virtue of the appearance of new receptors and modes of sense.

Acuity of sense. Sensory acuity is not necessarily directly variable with mental status. The vertebrate series exhibits specialization of sense and variation of acuity, but they are correlated rather with environmental demands and mode of life than with general psychobiological or neurological development. There are various vertebrates in which the contact senses are much more acute and more highly developed than in any primate; others, in which the status of the chemical senses of taste and smell makes that of the primate appear inferior or even degenerate. Specialization and evolution evidently have proceeded along other lines than simple increase in keenness of sense and variety of sense modes.

Within the four groups of primates which we are endeavoring to compare, contrasts in acuity are manifest. Certain of the Prosimiae are known to be extremely sensitive to contacts and sounds. Probably for these sense modes their acuity exceeds that of any other primate. This is one among many observations which we might cite as contraindicating the assumption that in general acuity of sense tends to increase through lemur, monkey, ape, and man. The fact is that whereas in one sense, or some particular aspect of a sense, this may be true, in others it certainly is not true.

Complexity of sense. Vision, originally describable as sensitivity to light, is supplemented in the course of phylogenesis by sensitivity to color. Receptivity is thus rendered more complex and an additional system of sense qualities is added. Is color vision lacking in any group of primates? Probably not, unless in the lemur. Do number of sense qualities and fineness of discrimination in either the light or color series vary in the primate types, and is there tendency toward increasing complexity in these respects from lemur to man? Although decisive observations are lacking we may answer, "Probably." Indeed the usual assumption, and the working hypothesis of many investigators, is that both complexity and fineness of discrimination of certain modes of sense increase rapidly from lemur to man. This generalization is of limited applicability because there is evidence that whereas some sense modes tend to develop in complexity and service-

ability, others tend to degenerate. Later we shall illustrate this point by contrasting the status of smell and sight.

Contact versus distance senses. Evolutional process in the mammalia evidently has favored the sensory projection of the organism in time and space. Sensitivity to contacts and pressure; to chemical activity, as in olfaction and gustation; to vibration of air as in hearing, and of ether as in vision, mark advances in sensory awareness of the increasingly remote. Are there indications, it is pertinent for us to inquire, that this phylogenetic process has occurred or is occurring in the primates? We shall endeavor to reply.

Pertinent are certain structural observations. The neural mechanism of smell is relatively large, conspicuous, and presumably functionally important in lemur as contrasted with tarsius, whereas for the mechanism of sight the reverse is true. From these morphological contrasts it has been inferred that in lemur smell is superior to vision and in tarsius vision to smell. The matter is discussed at length by G. Elliot Smith, who, profoundly impressed by the structural dissimilarities of lemur and tarsius, describes the latter as probable ancestor of monkey, ape, and man. The lemur he considers divergent and therefore less intimately related to man. His point of view, facts, inferences, and surmises, as relevant to our present discussion, may be summarized with extreme brevity.

Tarsius, Smith believes, represents specialization of vision and its cerebral mechanism, for in the surviving example of the family, *Tarsius spectrum,* the olfactory mechanism is greatly reduced and that of vision greatly enlarged. Relative to the condition of the cerebral cortex, he says: "My own studies enable me to say that its [tarsius] visual cortex is not only more extensive than that of the Lemuroidea, but also more highly differentiated and more like that of the Apes. The other regions of the cortex, however, conform much more closely to the corresponding areas in the Lemuroidea, both in extent and in structure, than to those of the Apes." (32, p. 469.) Further we are told that reduction of the face in tarsius seems to have permitted fuller development of stereoscopic vision and "this in turn stimulated the higher specialisation of the visual cortex and provided the guidance for the performance of movements of a much greater skill and precision. It was the cultivation of these powers that brought one branch of the Tarsioidea to Simian rank." (32, p. 469.) The author emphasizes also the relative lack of specialized structures and the relative superiority, presumably to Lemuroidea, of plasticity or functional adaptivity in tarsius. Further the Tarsioidea are described as "cultivating their intellectual powers rather than specialising for one particular kind of life. Their nimbleness of mind and agility of action enabled them to adapt themselves to a great variety of changing circumstances without sacrificing the generalised structure of their limbs; so that, when their opportunity came, they still had the mental and bodily plasticity to take advantage of it, and acquire the dominant position in the animal kingdom." (32, p. 466.) In lemurs and most monkeys as contrasted with tarsius, this author believes that specialization of structure and habit have precluded chances of preëminence.

That all of these facts and generalizations may safely be deduced from neurological conditions in the primates is not obvious. We cite as peculiarly uncertain, inference of psychobiological characteristics and capacities from neurological structure. Obviously, reliable knowledge of neural structure, behavior, and experience must take origin in direct verifiable observation. Therefore our inability to accept Smith's primarily inferential description of sensory, perceptual, and adaptational aspects of the life of tarsius and contrasted primates.

In view of relatively abundant and varied structural information and of fragmentary knowledge of mode of life and sensory characteristics, we may tentatively offer the generalization that from lemur to man contact and chemical senses tend to

diminish in complexity and value, whereas vision and possibly hearing also tend to become more complex, refined, and serviceable.

Status of photo-reception and seeing in the primates. Because vision is the only sense mode which in any of its many aspects has been intensively studied in other primates than man, and further because for this mode several important facts have been discovered, comparative survey is desirable.

Except by inference from neural structure and from general observation of behavior, nothing is definitely known concerning vision in lemur or tarsius. In representatives of both New World and Old World monkeys the existence of light and also of color vision has been demonstrated by the critical experiments of Kinnaman (25), Watson (38), Shepherd (31), and de Haan (8, 10). We mention as authorities only those investigators who have employed experimental method and attempted to control extraneous conditions and eliminate interfering stimuli.

Visual acuity and threshold of discrimination have been measured in certain New World monkeys with rare ingenuity, skill, and precision by Johnson (19-22), whose exceptionally valuable techniques as highly merit descriptive characterization as do the results of his investigation.

For measurement of acuity this investigator presented to his subject two visual fields, on each of which appeared horizontal black and white striae of equal width with respect to each other but variable in absolute width. The subject was required to respond appropriately to this variable. Referring to a species of New World primate, the investigator states that "The visual acuity of the monkey compares favorably with that of the human subject under similar conditions." (20, p. 361.) By use of similar technique Johnson determined the threshold of discrimination for a male capuchin. Of the result he states: "When the full effect of practice has been obtained, Monkey 2, under optimal conditions, can distinguish differences in width of striae of less than 3%. These values are of the same order of magnitude as those obtained by the method of limits on two human observers." (21, p. 187.)

Discriminative ability was further investigated by use of two striated fields which differed only in the direction of the striae. In case of the positive field, or that to be chosen by the animal, the direction was uniformly horizontal, whereas in the negative field it varied measurably from the horizontal. In this experiment the male capuchin previously referred to "perfected his habit in the first series of 20 trials. One chick failed to learn the problem and another chick required 58 days and 585 trials to perfect the habit." (22, p. 204.) The chick in this case was used as comparison subject. "The monkey's difference-threshold for direction of elements of a pattern lies between 2° and 5°; and the chick's threshold between 25° and 40°. . . . The relative improvement brought about by training is very much greater for the monkey than for the chicken." (P. 204.)

These results suggest that in certain at least of its aspects vision may be approximately as acute and visual discrimination as refined in monkey as in man.

Ability in the monkey to perceive visually and respond appropriately to differences in form and size of objects has been demonstrated and measured by Kinnaman (25) and de Haan (10, 11, 12), and the latter has observed also visual discrimination of pictures of objects which differed in shape. Limitations of visual perception have been exhibited and discussed by Kohts (25a, pp. 348 ff.). According to the observations of this authority visual attention is much less inclusive in *Macacus rhesus* than in chimpanzee.

These results seem to indicate that visual processes and seeing in monkeys are more varied, complex, and highly developed than in any other mammal similarly studied except chimpanzee and man. Perhaps the suggestion is justified that monkey differs visually from man rather in what it sees, the

configuration of the object observed, than in number or variety of sense qualities and acuity of discrimination.

For gibbon, siamang, and all the great apes except chimpanzee, relevant observations are lacking. As we have elsewhere fully reported (pp. 315 ff.) Köhler and also Kohts have established the existence of light and color vision in chimpanzee, and their experiments on visual perception reveal ability to discriminate on the basis of form, size, distance, and surface appearance. For no one of the anthropoid apes are there available measurements of visual acuity, or of fineness of discrimination, comparable with those of Johnson for monkey, man, and chick.

It has not been established beyond question, although results at present suggest the inference, that light and color vision are somewhat more highly developed and more humanoid in chimpanzee than in monkey, nor are there data for visual perception which permit quantitative comparisons. But whether or not vision in the anthropoid ape is superior to that in the monkey, it has been definitely proved to be markedly like the human in important features. Consequently it is highly probable that monkey and ape see more nearly as does man than do the lemurs.

INTELLIGENCE—CONDITIONS AND FORMS OF BEHAVIORAL ADAPTATION

Again completeness of survey is impracticable and it is necessary to select for mention a few groups of fact which are of extraordinary importance and offer marked contrasts among the primate types.

Curiosity and its expressions. No single and simple tendency or order of importance has been discovered for curiosity as indicated in such behavior as fooling, aping, destroying, examining. Nevertheless, critical scrutiny of available information supports the generalization that tendency toward persistent, thoroughgoing, and systematic examination and trial of objects and situations markedly increases from lemur to man. There is scant evidence of highly developed and adaptively serviceable inquisitiveness in the Prosimiae; in the monkeys, however, it is conspicuous, and in the apes, obviously more serviceable than in any animal except man. Clearly, in all of the primates the assemblage of activities suggested by the term curiosity constitutes a highly important partial basis for progress. It is through such behavior, which finally in the anthropoid apes and man appears as purposive examination of objects, that these organisms gain such intimate and extended acquaintance with the characteristics of environment that they are able to achieve varied and highly perfected adaptations. Initially, and especially in the Prosimiae, expressions of curiosity serve to provide useful sensory data, whereas finally, and especially in apes and man as contrasted with monkeys, such activities in large measure provide that acquaintance with environment which is necessary for anticipation, prediction, preadaptation, discovery, invention. It would be difficult to exaggerate the psychobiological value of curiosity in primates. Its complete description will ultimately throw a flood of light on many puzzling aspects of behavioral adaptation.

Certain conditions of learning. Among important general conditions of behavioral adaptation there are three which we would use to exemplify contrast in primate status. They are: attention, imitation, and instruction.

Attention is necessary to all of the so-called higher or intelligent forms of learning. From lemur to man it changes in several respects or dimensions. Constancy, degree of concentration, temporal span, and degree of voluntariness tend to increase. Quantitative comparisons are impossible because the necessary measurements are not available, but general observation convinces us that experimental examination of attentional processes in the primate types and measure of their principal characteristics will eventually establish the generalization which we have proposed. (See especially Kohts, 25a.)

Imitation, although frequently described as a mode of learning, we prefer to consider a condition, for in essence it is the influence of social copy or tradition on the adaptively directed efforts of the individual. If we limit our present consideration to relatively complex activities which are imitative with respect both to means and end and by general consent are classifiable as intelligent, the following general statements may be made. For none of the Prosimiae has such behavior been reported. In monkeys, however, in addition to a multiplicity of simple expressions of imitative influence, complex, and presumably also intelligent, imitative acts have occasionally been observed. Present knowledge indicates that they are rare, and, moreover, authorities disagree, for among those who as experimentalists have given systematic attention to the subject, Kinnaman (25) and Haggerty (13) affirm and present convincing evidence of their appearance; Thorndike (35) and Watson (37) report failure to discover them and doubt their occurrence, and Kohts (25a, p. 349) states that "the greatly developed imitative faculty of monkeys seems greatly exaggerated." In our opinion, the positive evidence prevails and strongly supports our generalization. Observational report does not justify assertion that imitative behavior in gibbon and siamang is more complex, intelligent, or otherwise highly developed than in certain monkeys. Present knowledge does not justify comparison.

As stated in the previous chapter, in the order gorilla, orang-outan, chimpanzee, the great apes provide evidence of increasing frequency, complexity, and serviceableness of imitative behavior. It is indicated, then, that intraspecies imitation occurs in all of our four groups of primate, but with increasingly abundant and convincing indications of insight and purpose in the order: lemur, monkey, ape, man. Extra-species imitation, and more particularly imitation of man by other primates, is unrecorded for lemurs, has rarely been observed in monkeys, is little known in gibbon and siamang, occurs, according to present evidence, occasionally in gorilla, more frequently in orang-outan, and most often in chimpanzee.

Histrionic ability, mentioned in the previous chapter as conspicuously characteristic of the chimpanzee, has not been described in the Prosimiae and is relatively simple and of infrequent occurrence in most sorts of monkey, whereas in the great apes it is commonly observed and has many times been described. With considerable assurance, even on the basis of incomplete information, we present as order of increasing tendency to exhibitionistic and histrionic behavior, and also of complexity and psychobiological importance of such behavior: lemur, monkey, ape, man. Present knowledge gives the chimpanzee first place among infrahuman primates as actor and as imitator.

As third and last example of condition of learning we present instruction or tuition. As in the case of imitative influence, this may be either intraspecies or extraspecies. In lemur instructional influence has not been recorded. Possibly it may appear in the relations of parent to young. Probably instruction of these primitive types of primate by man is relatively difficult. It has been decisively proved that human tuition may be effective in monkeys and apes. The former may be instructed by the process of "putting through," by supply of imitative copy, and as well by various other forms of assistance; but the latter are much more frequently, rapidly, and markedly influenced. It is a matter of common knowledge that orang-outan and chimpanzee learn much from human association and much also by human instruction.

Parental instruction of young, although not observed in lemur, has occasionally been noted in monkeys, is frequent in anthropoid apes, and in man, according to the conviction of many of those taught, is overdone! In the light of such information and related generalizations as we have presented, the statements of Lashley and Watson (26, p. 139), as quoted below, are both interesting and puzzling. At the conclusion of their de-

scription of the early development of a young rhesus monkey, they say: "There is, however, no evidence to show that the infant monkey ever gained a new activity by imitation. Walking, climbing, leaping, eating, and even the different vocal sounds appeared as instinctive acts which were merely perfected by practice." Whatever the facts for monkeys, the prevalence of parental tuition in apes is established.

Capacity for intraspecies or extra-species instruction is uniquely significant, since it marks the appearance of a type of social relationship—that of teacher to pupil—which, although rarely manifest in mammals other than the primates, perhaps exists in all types of the latter and certainly becomes increasingly important in monkey, ape, and man.

Attention, imitation, tuition, instruction, as conditions of "learning," steadily increase in importance in correspondence with complexity of environment and demands and opportunities for behavioral adaptation. In the progress from lemur through monkey and ape to man the individual must, in one way or another, achieve mastery of an increasingly complex environment. Unless supplemented by such potentially significant aids as imitation, tuition, instruction, and various forms of social tradition, it is difficult to imagine successful individual adjustment. Simple indeed, by comparison with that of the anthropoid ape, is the environment of lemur; simple also that of primitive as contrasted with cultured man. Therefore the consummate value of tuition or instruction as aid in individual adaptation and its obviously increasing conspicuousness in the series: lemur, monkey, ape, man.

Modes of adaptation. To exhibit typical contrasts we shall characterize three strikingly different but genetically related types of behavioral adjustment: learning by accident, with insight, with foresight.

Achievement of useful functional adaptations as result of accidental successes in connection with the behavior so often described as "trial and error" is observed in all of the primate types. That it diminishes in frequency from lemur to man has not been proved, but that its relative importance diminishes because of the appearance of other and supplementary modes of adjustment is certain. Our previous descriptions of this general mode of adaptation to environmental requirements, or method of solving problems, render further comment entirely unnecessary.

Learning with insight implies the presence of ideational processes or their functional equivalents, ability to perceive relations, and perhaps also to analyze and synthesize mental objects. That these occur in other organisms than man, scientists have very commonly doubted or denied. Recently, experimental studies of the primates have supplied data which establish the existence in monkey and ape of forms of behavioral adaptation with insight. We have discovered no positive evidences for the Prosimiae. Ideational learning, in the judgment of Kinnaman (25), occurs in the monkey. By Kohts (25a) it has been demonstrated that in *M. rhesus* behavioral adaptation to experimental problems is markedly less efficient than in ape and man. Johnson (21, p. 187), in his study of visual discrimination in the monkey, observed that his subject "eventually learned to respond on the basis of relative size," instead of to a particular visual object. Ability to respond to relation as contrasted with familiar object, or as Köhler chooses to describe it, to the configuration or structure-function value of the situation, has been demonstrated also in anthropoid apes. It is known, furthermore, to be common in man. Therefore the conclusion is justified that ability to perceive and respond to relations, although unknown in the Prosimiae, becomes increasingly important in the order: monkey, ape, man.

Learning with insight may further be exemplified by reference to the type of problematic situation which is frequently described as indirect course with implement. Adaptation requires that the organism use stick or other object as implement to push

or pull a desired object within reach. Obstructions necessitate that the object, instead of being pulled directly toward the subject, must at one point or another be pushed directly away from it and then, in a more or less indirect course, drawn toward it. For the normal mature human subject this is an extremely simple problem. It may readily be presented to any primate. As far as observation has proceeded, contrasts are notable. The Prosimiae apparently have not been tested with this type of problem. Monkeys, in accordance with our own observations and those of Nellmann and Trendelenburg (27), are incapable of achieving adaptation, but, as will later appear, they are also relatively inapt in the use of objects as tools, and this type of problem therefore transcends their behavioral resources. The chimpanzee, as representative of the anthropoid apes, succeeds readily in meeting the requirements of the problem, whereas, so far as observed, the gorilla has failed. We may summarize observations in the generalization: Ability to obtain a desired object by moving it through indirect course with stick seemingly is lacking in lemur and monkey, although definitely present in anthropoid ape and man. In passing from consideration of insight to foresight, we should state that in a later section on instrumentation and constructivity there are presented additional evidences of learning with insight.

Indicative of the psychobiological processes of foresight, and of capacity for adaptation on the basis thereof, are such activities as are implied by the terms expectation, anticipation, surprise, disappointment, preparedness, preadaptation. No indications of behavior thus describable have been reported for lemur. For the monkey, by contrast, positive evidences are at hand. Convincingly expressed are expectation, anticipation, and disappointment (Tinklepaugh, 36, pp. 224 ff.), but in the light of present knowledge learning with foresight, or preadaptation of behavior, is relatively rare in this primate group. In the anthropoid apes it has frequently been observed and carefully reported. Among the varied evidences at hand for great apes are those supplied by expression of attitude toward prospective tasks; definite provision of objects required for the solution of problems; indirection or cunning in the achievement of ends; almost human expressions of disappointment, surprise, amazement, incredulity. If it be objected that these are in the main affective phenomena, which presumably cannot condition learning, we must reply that behavioral adjustment actually occurs in conjunction with, or following, such expressions as have been mentioned. Assuredly learning with foresight appears somewhere in the series lemur, monkey, ape, and becomes highly serviceable in anthropoid ape and man.

Memory. To judge from scanty and relatively unsatisfactory evidences, mnemonic processes become increasingly valuable from lemur to man by reason of imagery (see Révész, 30), lengthening temporal span, and appearance and growth of ability to analyze and synthesize mental objects. It is indicated that memory for persons, for concealed food, and for artificially simplified objects, is much more common, enduring, and useful in ape and man than in lemur and monkey. Temporal span of memory seemingly increases in the primates from minutes or hours in the Prosimiae, hours, days, or weeks in the monkeys, hours to months in the apes, and indefinite periods in man. Experiments have demonstrated that under conditions in which other mammals can respond appropriately on the basis of mnemonic processes only when delays are limited to a few seconds or at most a few minutes, certain monkeys and anthropoid apes may succeed after hours or days. Similarly, it appears that whereas behavioral manifestations of familiarity and recognition are unknown in lemur and occasionally observed in monkey, they are impressively similar to human responses in the anthropoid apes.

Results of experiments suggest that ability to react to elements or aspects of situations, although practically absent in

the Prosimiae, is detectable in monkeys, well developed in anthropoid apes, and supremely important in man. In primitive primates, as in many other types of mammal, locational or positional factors tend to determine mnemonic response. Gradually in the primate series other factors achieve importance, until finally in man, and in lesser degree in anthropoid ape and monkey, factors other than the locational or positional, become potential determiners of response.

Beyond doubt, memory, as condition and aspect of behavioral adjustment, becomes increasingly important from lemur to man. Probably it differs more significantly in quality and variety of mnemonic process than in quantity or degree of functional expression.

Imagination. The terms ingenuity, inventiveness, versatility, although inapplicable to prosimian behavior, are necessary with increasing frequency in characterization of the activities of monkey, ape, and man. Evidences of creative imagination, as contrasted with memory, may be observed in the playful activities of monkeys and apes. The latter especially tend to invent ways of amusing themselves and to develop frequently, under conditions of imitation or tuition, performances which are complex and compel the attention of human observers. In methods of endeavoring to solve problems or to manipulate environment adaptively, monkeys and, still more, anthropoid apes exhibit versatility, ingenuity, and inventiveness. Not infrequently there may be observed in the great apes evidences of the organization of activity, or, in common parlance, planning, which as Köhler (1925) has remarked, indicates that for certain other primates than man the whole is greater than its parts. From scant behavioral evidence of creative imagination in lemur, observational data indicate rapidly increasing prevalence and adaptive value in monkey, ape, and man.

Mechanical ability. By this phrase we would indicate something distinguishable, on the one hand, from manual dexterity and skill, and, on the other, from ability to use objects as tools. In man mechanical ability or abilities vary extremely from individual to individual. Some are highly gifted, others almost devoid of this capacity. The ability is not indicated by available descriptions of the behavior of lemurs. It has been observed in monkeys; it is known to be highly developed, although individually variable, in the chimpanzee, and present in varying measure in the other anthropoid apes. Generalization is not warranted by available information. That the subject is worthy of systematic attention and especially of ingenious experimental inquiry is obvious, for cultural progress to a very considerable degree is dependent upon mechanical aptitude, skill, genius.

Instrumentation. Among the primate types appears increasing tendency to modify environment in the interest of welfare and comfort. One of the most impressive expressions of this tendency is the utilization of objects as tools. Search of the literature reveals complete lack of evidence of such behavior in the Prosimiae; indications that only the simplest forms of instrumentation appear in monkeys; abundant proof of the phenomenon in a variety of forms in the anthropoid apes, as also in man. Manifestly, instrumentation becomes increasingly possible and important between lemur and man. Probably it is one of the best indicators of mental status. Assuredly it places the anthropoid apes next to man in ability to achieve adaptation through modification of environment, and at the same time it indicates a great gulf between monkey and ape.

Tendency to construct implements, or so to modify environment that objects shall acquire instrumental value, has been observed only in anthropoid ape and man. Apparently rare in the former, it may possibly be due chiefly to association with man, for it is known that the apes profit rapidly and greatly by human example and tuition.

Indices of behavioral adaptivity. As far as may be determined from available data, the orders of increasing rate, range, variety, and generalization of behavioral ad-

justment in the primates are identical and agree with the commonly accepted order of increasing intelligence: lemur, monkey, ape, man.

Summary of psychobiological contrasts. We shall attempt in these paragraphs to assemble the principal psychological contrasts among primate types. Our terminology, although often subjective, refers always, as we indicate in our initial sentence, primarily to behavioral expression.

Of outstanding importance among primate types are phylogenetic differences in behavioral expressions of curiosity, interest, attention, emotion, mood, sentiment; confidence in man and intelligent coöperation with him, rapidity and extent of adaptation to captivity; diversity and complexity of receptivity, sensibility, and perception, functional importance of contact senses, chemical senses, and distance senses, degree of value and dominance of hearing and vision; analysis and synthesis of mental objects; vocalization, approach to speech, intercommunication by visual and auditory signs or symbols; diversity of activity in problematic situations; frequency and importance of accidental (trial and error) adaptations; ability to perceive and react adaptively to relations (structure-function) *versus* familiar object; insight, understanding, anticipation, expectation, disappointment, foresight; preadaptation; temporal span and complexity of memory; creative imagination, versatility, ingenuity, inventiveness, constructivity; adaptive modification of environment, modification of other organisms by tuition or instruction, use of objects as implements, construction or fashioning of implements.

Some of these phenomena are observable in all primates, some in all except the Prosimiae, others only in ape and man, and a few in man alone. Usually vast gulfs separate the types, and with few exceptions the indicated or definitely demonstrated trend of development and serviceability is from lemur to man.

We list below, in supplementation of the special bibliography on anthropoid behavior at the end of the volume, those studies of *lemur, tarsius,* and *monkey* which we have used in preparing this chapter.

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CHAPTER FORTY-SIX

ANTHROPOID RESEARCH IN RETROSPECT AND PROSPECT

IT is our intention in this, our concluding chapter, to exhibit summarily (1) historical phases or stages in the progress of study of the anthropoid apes; (2) notable efforts during the first quarter of the twentieth century to use the great apes systematically instead of incidentally and sporadically as subjects of inquiry; (3) the present status of research endeavor; and (4) the possibility of methodological, informational, and social advance through ingenious experimental use of the anthropoid apes. The values which we prophetically anticipate are the justification alike of this extended historical and constructive exposition and of our faith in the potential usefulness of anthropoid materials.

MAN'S ACQUAINTANCE WITH ANTHROPOID APES

As oddities of the animal kingdom monkeys and apes for thousands of years have commanded human attention and stirred curiosity. Naturally enough the large apes seemed to observing man like caricatures of himself and were initially described as such. For a long time descriptions continued to be the imperfect products of crude observation and superstitious imaginings. The length of this prescientific stage of anthropoid knowledge is unknown. Throughout it is characterized by the influence of curiosity controlled by superstition.

In time the accumulation of mutually conflicting or contradictory reports, descriptions, comments, became seriously confusing, and the human tendency to seek logical orderliness began to express itself in efforts at classification. As a result there appeared eventually classificatory terminology, descriptions of types, and like aids to identification and characterization. The fascination of ability to identify and classify steadily grew, and its yield was a rich harvest of observations relative to external appearance, mode of life, ecological relations, and gross structure. Thus slowly, haltingly, and with many backward steps because of careless observation, inaccurate description, and erroneous classification, knowledge grew. The stage of classification marked the advent of scientific spirit, point of view, and procedure.

Stimulated increasingly by insatiable curiosity and the demand for additional aids to classification, observation of the apes gradually was extended to include internal structure and generation. Simultaneously the interests of hunter, collector, and naturalist achieved expression, and habits and habitat, the manner and conditions of anthropoid life, became increasingly matters of remark, record, and careful description. It was the era of gross anatomy and natural history. Whether chronologically or in importance the one takes precedence of the other we do not know. Assuredly both types of interest and scientific equipment have made, and continue to make, their significant contribution to the sum of knowledge, technical skill, and insight.

Finally, during the nineteenth century, almost all aspects of anthropoid organization and life, except the psychobiological, were subjected to survey and, in isolated instances, to thorough study. The sum of knowledge increased enormously, yet on every hand appeared gaps, uncertainties, inaccuracies.

If in a few words we should attempt to summarize trends and characteristics of human acquaintance with the anthropoid apes, we should say that the prescientific era of crude anthropomorphic description gradually, through the influence of discovery of necessity for identificational characteriza-

tion and classification, gave place to the interests, ideals, and procedures which have come to be known as scientific. Likewise classification created demand for morphological and ecological information, and eventually the era of morphology was ushered in. Then, as specialization increased and it was realized that function is the biological reason for the existence of structure, physiological, pathological, and neurological inquiries came to abound, and to extend and supplement importantly the results of earlier naturalistic observation.

It is a fair question whether the completion of this brief description of stages in the development of knowledge of the anthropoid apes does not demand the prophecy that from the vantage ground of the historian, psychobiological interest will appear to be characteristic of the current century and dominant in our era.[1]

[1] Concerning relations of science to primate materials, one of us several years ago prepared a statement which will serve to supplement our present outline of progress in anthropoid research:

"Biologists are generally agreed that the study of the primates, and especially of the monkeys and anthropoid apes, is of extreme importance. It is evident that this work, nevertheless, has been neglected. We have but fragmentary and unsatisfactory knowledge of the structure and development (gross anatomy, histology, embryology) of most of the primates; we know less, definitely, concerning their physiological processes, diseases and pathological anatomy; still less, of the phenomena of heredity and of their life history; and next to nothing, with certainty, concerning their instincts, habits, other individual modes of behavior, mental life, and social relations.

"The reasons for this ignorance where knowledge might reasonably be expected are not difficult to discover. Most investigators are either impelled or compelled by circumstances to work on easily available and readily manageable organisms. Many of the primates fail to meet these requirements, for they are relatively difficult and expensive to obtain by importation or breeding, and to keep in normal condition. It is clear from an examination of the literature on these organisms and a survey of the present biological situation that the neglect by scientists of systematic study of all of the primates excepting man is due, not to lack of appreciation of their scientific value, but instead, to technical difficulties and the costliness of research." (Yerkes, 1916a, p. 231.)

ATTEMPTS TO PROVIDE FOR SYSTEMATIC STUDY OF ANTHROPOID APES

As we have endeavored to indicate in the foregoing chapters, knowledge of the anthropoid apes has progressed more often by cursory, incidental, accidental, and fragmentary observation than as result of systematic and sustained endeavor. We would now review historically, and as far as possible chronologically, the few attempts to provide for psychobiological aspects of anthropoid research. Intentionally we shall omit mention of naturalistic or collecting expeditions and of transient or long continued but usually somewhat sporadic observations of travelers, hunters, and animal trainers and caretakers in zoölogical gardens, menageries, and circuses. For although from such work much valuable information has come, it is fragmentary and therefore also relatively unsatisfactory.

The situation suggests a picture puzzle, parts of which have been discovered and described by various observers, while because of the lack of wisely planned, carefully coördinated, systematic, and sustained effort the picture itself, with its many biologically significant configurational aspects, is unknown. As one reflects on the situation, it seems strange indeed that the study of the anthropoid apes should have been so largely piecemeal, so inefficient, and so impressively meager in its results. Opportunities have not lacked for carefully planned and continuing attempts to discover the pattern of the intricate biological puzzle, but seldom it seems have qualified individual and opportunity met. For decades the zoölogical gardens of the world have held captive specimens of gibbon, siamang, orang-outan, chimpanzee, and gorilla. Often the individuals have lived for many years, and occasionally they have bred, in reasonably satisfactory environment. Yet, almost without exception, the scientific use of these exhibition specimens has been neglected. Evidently there is opportunity for some progressive zoölogical-garden director

to lead the way and establish a fashion by converting his establishment into a center for biological research without undesirably

Fig. 166. View of the Abreu Primate Colony at Havana, Cuba. Courtesy of H. C. Bingham and the Century Company.

sacrificing its primary function of entertainment and education. But we must proceed with our historical survey.

The Abreu primate colony in Havana, Cuba, although maintained primarily to satisfy the owner's nonscientific interest in pets and to entertain her, incidentally has proved of very considerable value to investigators and therefore should be mentioned in the present connection. Established early in the century, at various times it has contained, in addition to many other primates, representatives of gibbon, orang-outan, and chimpanzee. Of first importance is the success of Mrs. Abreu in breeding and rearing chimpanzees in captivity. In its scientific aspects and relations, this colony has been fully described by Yerkes (1925). Results of studies made in Havana by courtesy of Mrs. Abreu have been published also by Bingham (1927, 1928).

As typical of what has happened several times in various parts of the world, mention may be made of the Furness collection and observations. As in case of the Abreu colony, the owner of the animals lacked scientific training but was intelligently interested in various aspects of the life of his captives and endeavored to make them contribute to human knowledge. Happily, in the case of Furness, publication relative to the psychobiology of orang-outan and chimpanzee resulted. Nevertheless, it is clear that this and other similar attempts on the part of laymen to keep anthropoid apes as pets and observational subjects may not properly be classed as scientific projects.

Beginning about 1910, G. V. Hamilton maintained for his private use at Santa Barbara, California, a primate colony which, although consisting chiefly of monkeys, included at least one anthropoid ape. The scientist-owner was interested chiefly in problems of psychopathology, and for years he utilized primates in the experimental study of the nature and conditions of behavioral adjustment and maladjustment. Descriptions of the colony and results of its scientific use are to be found in Hamilton (14-17, see numbered bibliography, p. 579). It was in the Hamilton colony and with the owner's generous coöperation that Yerkes (1916) conducted his pioneer comparative study of behavioral adaptivity in monkey and orang-outan. In 1918 Hamilton discontinued his work at Santa Barbara, and the colony was abandoned.

As result of the scientific interests, influence, and promotional activities of Rothmann and Waldeyer in Berlin, about 1912 a German station for the utilization of anthropoid apes in biological research was established on Tenerife, the Canary Islands. It was planned to use the station initially for studies in functional neurology and psychology. The first resident investi-

Fig. 167. Cages for anthropoid apes on the Abreu estate in Havana. Courtesy of H. C. Bingham and the Century Company.

gator was the psychologist E. Teuber; the second, also a psychologist, was W. Köhler. In 1918, following the War, and because of inadequate support, this important effort to provide adequately for certain phases of anthropoid research was abandoned. The history of the Canary Island Station, descriptions of it, and results of investigations conducted there, appear in Rothmann (1912), Waldeyer-Hartz (1917, 1919), Rothmann and Teuber (1915), and Köhler (all titles).

In the Department of Zoöpsychology of the Darwinian Museum, Moscow, Russia, beginning about 1916 and continuing for some years, Mrs. Kohts used a chimpanzee and also some monkeys for systematic experimental study of various psychobiological problems. Although the establishment in question is not primarily an institute for anthropoid research, it seems legitimate to mention it because of the notably important contributions to anthropoid literature which have come from it. Additional information may be obtained from the publications of Kohts (1921, 1923, 1928), and Yerkes and Petrunkevitch (1925).

In fulfilment of hopes expressed by Metchnikoff, and under the direction of Calmette, immediately following the World War the Pasteur Institute of Paris undertook to establish and develop at Kindia, French Guinea, a station for the experimental use of anthropoid apes and other primates in the study of medical problems. This establishment, which has now been in operation for several years, has developed steadily. According to published reports, scores of chimpanzees have been utilized as subjects of medical experiment. It is announced that other lines of inquiry than medical will, as possible and practicable, be provided for and encouraged at "Pastoria." Accounts of the purpose, plan, site, buildings, and equipment of this station, or reports of investigations, may be found in Calmette (1924), Honoré (1927), Wilbert and Delorme (1927), and publications not included in our bibliography which have appeared in the *Annales de l'Institut Pasteur,* Paris.

In association with the Institute of Psychology, Yale University, there was established at New Haven, Connecticut, in 1924, a special laboratory for anthropoid research. In this laboratory provision was

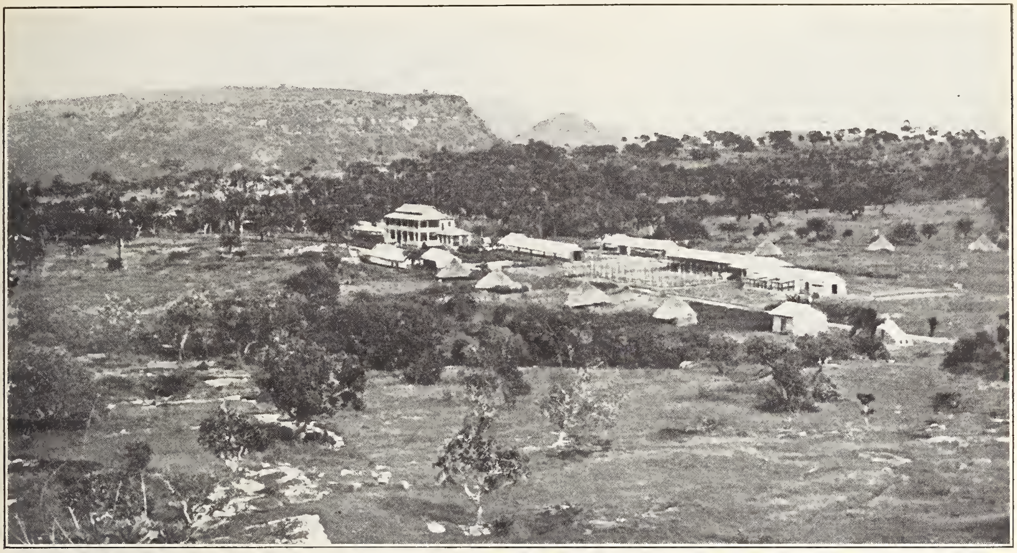

Fig. 168. General view of the station and laboratories of the Pasteur Institute at Kindia, Africa. Courtesy of A. Calmette and R. Wilbert.

Fig. 169. The setting of the Pasteur Institute Station at Kindia. Courtesy of A. Calmette and R. Wilbert.

Fig. 170. Interior of primate quarters, Pasteur Institute Station, Kindia. Courtesy of A. Calmette and R. Wilbert.

originally made for specialization on psychobiological problems and the utilization of the chimpanzee as subject. This establishment represents the first step toward the consummation of a plan for the thoroughgoing systematic investigation of anthropoid life and structure proposed by Yerkes (1916a), and re-presented subsequently in modified form and in conjunction with a program of research (1927b).

The plan calls for three types of coördinated establishment which shall together provide for the intensive study of all aspects of the life of the anthropoid apes: (1) Stations or headquarter camps for observation of the animals in their natural habitat; (2) subtropical breeding station for study of reproduction, life history, and rearing of subjects for investigation of special problems; and (3) adequately equipped special laboratories for the study of form, function, and various psychobiological and social problems.

The list of definite attempts to provide for special study of anthropoid life and utilization of the apes in science has been completed. It is disappointingly brief.

PRESENT STATUS OF ANTHROPOID RESEARCH

There is now unprecedented interest in the structural organization, classification, and life of the anthropoid apes and they are being studied more generally and intensively than ever before. But obviously enough, adequate provision for continuing investigation of problems of function has not yet been fully achieved. Of the several establishments and attempts at research which we have briefly described only three have continued to this date: the Abreu colony exists as potentially useful for the study of anthropoid life; the Kindia Station of the Pasteur Institute may extend its scope and provide for the study of other than strictly medical problems, and the Primate Laboratory of Yale University, in which several investigations are now in progress, is about to be supplemented by the establishment of a breeding and obser-

vation station, and also, it is hoped, affiliated field stations.

In this attempt to describe very briefly the status of anthropoid research we are intentionally ignoring everything except defi-

Fig. 171. Building and outdoor cages of Primate Laboratory, at Yale University, New Haven, Connecticut.

nite plans, provisions, or both, for naturalistic and experimental study of problems in social biology and psychobiology. Despite their importance and supplementary value, we therefore omit mention of expeditions, continuing taxonomic, morphologic, and anthropometric studies. At the moment encouragement must be taken rather from growing interest and improving prospects than from actual achievements. Although such provisions for research as seem eminently desirable have not been achieved, current interest, promotional activity, and the establishment of new centers of work and new types of laboratory, fully justify expectation of rapid progress.

The definitely indicated lines of development, for each of which observational provisions exist or are being made, are four, which we may thus describe in terms of their objectives.

(1) Increasingly adequate arrangements for observation of the free wild life, the habitat, and ecological relations of each of the anthropoid apes. This implies more than hunter, collector, or wandering field naturalist can supply. Semipermanent observational headquarters or stations must be established where work may be continued uninterruptedly for years and where observations on mode of life and environmental relations may be checked, verified, and supplemented as desirable.

(2) The reservation of suitable areas, and the establishment of stations, for the breeding of anthropoid apes either in captivity or in semicaptivity are now recognized as entirely essential for satisfactory study of life history, including various aspects of the process of reproduction. Indicative of appreciation of need, interest, and progress are the recent establishment of a safeguarded area for *Gorilla beringei* in the Parc National Albert of the Belgian Congo, and the plan to supplement the Yale Primate Laboratory by establishment of an American subtropical breeding station.

(3) Absolutely essential to the efficient comparative study of many important aspects of the life of the anthropoid apes are the development and standardization of methods of observation and measurement. In the past, investigators, in accordance with individual desire or ingenuity, have used more or less satisfactory but markedly differing methods. Consequently their re-

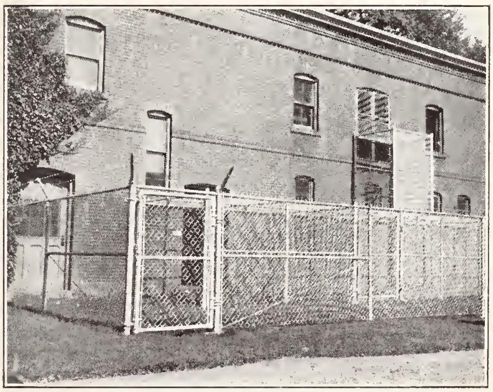

Fig. 172. Yale Primate Laboratory at New Haven, Connecticut.

sults cannot be compared. One of the principal present coöperative undertakings in the Yale Primate Laboratory is the invention, adaptation, and standardization of methods of measuring various forms and

aspects of anthropoid behavior; the development of methods of treating observational results statistically and of expressing them in readily comparable terms, and finally, of obtaining, through the application of satisfactory standardized methods and by reliable treatment and expression of results, norms for sex, age, and species, in case of several obviously important aspects and dimensions of behavior. Given standardized methods of measurement, suitable modes of quantitative expression or coefficients of ability, and trustworthy standards of performance, comparison of the anthropoid apes among themselves and with man and other primates will be possible and profitable.

(4) Increasingly evident as matter of desire and as prospective achievement is provision for intensive work on particular problems which demand elaborate, costly, or for other reasons difficultly obtained and manipulated apparatus and facilities for observation. Evidently it is preferable to take the anthropoid subject to the existent specially equipped laboratory instead of attempting to create laboratories for work exclusively with anthropoid apes. Professional investigators are more often interested in problems than in a particular type of organism which may on occasion serve as subject. Consequently the prospect that even if special establishments such as the Yale Primate Laboratory come into existence, anthropoid apes will be used increasingly, if made available by breeding stations, in laboratories which specialize on problem-defined interests but not necessarily on type of organism.

However serious defects or inadequacies of present provisions for study of the anthropoid apes and however inaccurate and incomplete our present knowledge, the content of the foregoing chapters, and the data presented in our subjoined bibliography, exhibit remarkable contrast as between observational procedure, accuracy of report, and general adequacy of information in the nineteenth century and today. During the first quarter of the twentieth century contributions to the psychobiology and other aspects of the life of the anthropoid apes were unprecedentedly numerous and important (Yerkes and Child, 1927). This fact is encouraging and its recognition may serve partially to compensate for persistent faultfinding and adverse criticism in our description of the growth of knowledge.

OPPORTUNITIES AND PROSPECTS IN THE STUDY OF ANTHROPOID LIFE

In the previous sections of this chapter we have briefly reviewed the history of knowledge of anthropoid life, attempts to provide for increasingly satisfactory research, and the present status of inquiry. In concluding the chapter and volume, we shall attempt similarly to exhibit research opportunities and prospects. This we do, not in the spirit of prophecy, but instead with the hope of increasing interest and encouraging original work.

In endeavoring recently to answer the question Why anthropoid research? Yerkes (1927b, pp. 181 ff.) presented as fact and arguments considerations which have important bearing on the prospective and probable extension and perfecting of knowledge of anthropoid life and of the utilization of anthropoid apes for the solution of various biological problems. With minor changes we re-present the arguments.

The most general answer to the question proposed is: Because knowledge is preferable to ignorance, whether the subject be ape or microbe, rock or molecule, electricity or nerve impulse, vocal symbol or emotion. But the logically related inquiry, Why study anthropoid apes or any other infrahuman primate when so many idle and apparently nearly useless human subjects are at hand? cannot be convincingly answered so briefly and dogmatically. Why, indeed, should anthropoid apes be studied intensively?

Affirmative facts and arguments fall into two groups: those from availability and controllability and those from observational values. Although on the earth today men

greatly outnumber anthropoid apes, the latter actually are far more available for many kinds of research. This is primarily because to the use of human subjects there are varied and often insuperable economic, legal, moral, and sentimental objections or barriers. Strange to say, it appears that for our present civilization availability and controllability of human and anthropoid subjects are not greatly affected by supply. For many types of inquiry human subjects are readily available and may be freely used, but for others, and among them many which are fundamentally important for human welfare, they may not be used under existing regulations and public opinion because of incalculable risks to life, health, normal development, and social relations. Given a human infant as scientific subject, freedom of investigation is limited: given instead an anthropoid ape, only humane treatment and economy of resources need be considered.

So marked indeed is the contrast in degree of availability and controllability of man and ape that the latter only may be even considered for use in the investigation of various problems in *genetics*, as, for example, in experiment by selective mating, crossbreeding, and artificial fertilization; in *physiology,* where experimentation may involve operation on the living organism and other radical changes in the functional economy; in *neuro-* and *psychopathology,* for experimental control of neural development, production of atrophy or hypertrophy, inducement and control of mental defects and diseases; in *psychology* and *psychobiology,* especially for continuous controlled observation of origins, genetic relations, and values of major forms and aspects of experience and response; in *sociology,* for experiments involving prolonged isolation of the individual, segregation and control of social groups, analytical study and measurement of the values of social stimuli; in *pedagogy* and *experimental education,* for radical analyses of motivation, modes of adaptation, inhibition; for creation and reënforcement of behavioral patterns; for the creation, intensification, or suppression of interests; for the development and trial of new and possibly dangerous pedagogical procedures; and in *hygiene,* where extension of knowledge of the phenomena and hygiene of sex may require experimental studies of life history in isolation as contrasted with natural social environment; observation and attempted control of the sex impulse and its forms of expression, continuous and comparative study of sexual and other aspects of reproductive activity and experience throughout the life history of an individual.

For many of the lines of inquiry illustratively enumerated above, public opinion, investigative wisdom and insight dictate that the anthropoid ape be used initially at least in preference to man. In most instances it is a sheer matter of necessity, since human subjects cannot be used, but in any case use of the anthropoid subject will cost far less in dollars, labor, anxiety, risk of social censure or legal infringement.

Arguments from observational values as contrasted with those from availability and controllability are typified by the following. The anthropoid subject is highly and peculiarly useful for (1) trial and development of investigative techniques which may later be rendered applicable in the study of man; (2) tentative formulation of problems and their refinement or reformulation in the light of exploratory investigations—the whole procedure being viewed as preliminary to definite attack on specific problems which seem as important for the understanding and control of human life as for the anthropoid ape; (3) discovery of new investigative leads and of modes of directing or controlling vital phenomena, as for instance, in the study of behavioral adaptations, motivation, and sexual expressions and adjustments; (4) analysis of observational findings and comparative study thereof for the discovery of characteristics, genetic relations, developmental and evolutionary trends, and their biological significance.

Convincing though arguments from avail-

ability, controllability, and distinctive observational values of anthropoid ape versus man may appear, the immediate serviceability of anthropoid research to human psychobiology and social biology depends in large measure on the degree of relationship between ape and man. Therefore the appropriateness of the question: Is the anthropoid ape the natural and logical substitute for the human subject in psychobiological and related inquiries, or might one better choose some more readily available and easily controllable infrahuman subject, such as the dog, cat, guinea pig, or rat? The answer is supplied by well-attested fact, for structurally, physiologically, and psychologically, orang-outan, chimpanzee, and gorilla much more closely resemble man than does any other existing animal. Consequently these creatures must inevitably become the preferred substitutes for human subjects in investigations which may not be carried on with the latter and which have as objectives the extension of knowledge and control of human life.

To summarize the arguments for an affirmative answer to the question, Why anthropoid research? the anthropoid ape is the natural and desirable substitute for man in many types of investigation at this time and in our civilization because of (1) superior availability and controllability; (2) superior resemblance to man structurally, functionally, and experientially; and (3) consequent peculiar values of methodological, factual, inferential, and theoretical discoveries and formulations in anthropoid research.

Promise and prospect of increasingly rapid and effective extensions of anthropoid research appear also in the growing realization that modern insights, techniques, and material resources render practicable today undertakings which previously seemed impossible, and offer alluring possibilities of scientific achievement and human service. In the past, knowledge of anthropoid life has grown haltingly, irregularly, uncertainly because by fragmentary, unverified, and often unverifiable observations. Because of adverse conditions investigations have been relatively unsatisfactory: witness, attempted contributions to knowledge of courtship, mating, and other important aspects of the reproductive cycle, of life history, rate and conditions of growth, mode of life, hereditary and acquired modes of response. In the aggregate, a vast deal of work has been done on these subjects. The expenditure of labor has been enormous, the risk of human life considerable; yet the harvest of fact has been relatively slight. Obviously many things have been done poorly, although at great pains, which under carefully planned and appropriate conditions might have been done well. This assertion demands and deserves examination.

In the past, almost without exception, contributions to anthropoid life history, growth, and development have been made by those who as hunters, collectors, naturalists, experimentalists, morphologists, taxonomists, in field, museum, or laboratory, chanced to have opportunity to observe one or another specimen of ape whose pedigree, age, and previous history were unknown. As one reflects on the situation it appears first incredible, then ludicrous, that as professional scientists we should depend upon accident instead of intelligently planned and prearranged conditions for the extension of knowledge and the solution of significant problems. What, by contrast, should and well might be the conditions for study of such aspects of anthropoid life as we have mentioned illustratively? The answer is almost too obvious for statement. As has long been true for every other sort of systematic and highly developed form of biological inquiry, the anthropoid subjects should be bred under carefully prearranged and controlled conditions so that all essential facts concerning the individual would be matters of record instead of surmise, guess, or estimate. Both organism and environment should be observed, described, controlled in accordance with the requirements of the problems whose solution is sought. In a word, for accidental oppor-

tunity, prearranged and controlled conditions should be substituted.

Because the inexcusable inefficiency and inadequacy of early and still existent methods of studying anthropoid life, and indeed also of using apes for varied experimental inquiries, have become matters of attention, critical comment, even of ridicule, the improvement of the status of research is assured. Steadily improving facilities for work and increase of interest in publications presage radical changes in anthropoid research and in our knowledge of anthropoid life.

FORWARD MARCH!

Our survey of present knowledge of the life of the anthropoid apes and of possibilities and probabilities of extension is finished. Carefully using historical contributions to method, fact, insight, and interpretation as stepping-stones to progress, we may now more confidently go forward to the conquest of new realms of fact and the solution of novel problems. This volume, projected as preparation for anthropoid research, stands also as historical introduction to a train of papers, monographs, and books on phases of anthropoid life and on solution of biological problems in terms of that life which will increase with years. If it serves to inform the layman authoritatively and acceptably, to conserve the time of the investigator, to improve historical perspective, to increase respect for those who effectively use and generously acknowledge the contributions of their predecessors, to suggest problems, to reveal important opportunities for verifying or supplementing knowledge, to encourage and inspire more determined, enthusiastic, objective, and efficient study and use of the anthropoid apes for the enlightenment of mankind and the improvement of his lot, our regrets for the hours which have been lost to research will have been dissipated and our labors abundantly rewarded.

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SUBJECT AND AUTHOR INDEX

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